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NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

12648 (AFCRC-TN-60-1000) SOLID STATE RESEARCH. Quarterly Progress Report. (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Jan. 15, 1960. 101p. (AD-234915)

Research on semiconductor devices is reported in which it was found that the switching speed of monostable cryosars with 0.003 to 0.004 inch base widths was found to be contact dependent. Other work revealed that the peak and valley currents for tunnel diodes depend on the alloying temperature. Measurements of changes in surface recombination velocity for germanium are reported. Results indicate that chemisorption of hydrogen and/or oxygen leads to a decrease in the density of recombination centers. It was found that cold working InSb affects the etching behavior of its crystal surfaces. A model for InSb oxidation above 300°C is presented. Continued investigation of Seebeck coefficients and magnetic susceptibility for praseodymium oxide is reported. A method for determination of selenium in indium is reported. Phase studies of the indium–antimony–tellurium system were conducted and a general investigation was started of Group III B elements in the rhombohedral structures of Bi_2Te_3 and Sb_2Te_3 to study their chemical bonding. An evaluation of the effects of impurities on HgTe electric properties is reported. A method for determining effective scattering mechanism parameters in electron transport was found. Low temperature x-ray diffraction studies on vanadium sesquioxide show that the material undergoes a martensitic transformation at low temperatures. A very general approach to the definition of electric and magnetic susceptibilities is being developed. Operation of the L-band ruby maser and the CW 3-level maser is reported. Paramagnetic resonance studies are reported on V^{+3} in Al_2O_3 and O_2 in β-quinol clathrate. Experiments on interstitial transition metal alloys and magnetic-form-factor measurements made with a polarized neutron source are reported. Progress in gathering information on the origins of magnetic anisotropy in magnetic films is reported. Improved cryosar elements were investigated for use in high speed computers and the reliability of transistors in the TX-O computer was evaluated. Study of several materials for use in development of solid state digital display devices is in progress. (J.R.D.)

12649 (ANL-6231) CHEMICAL ENGINEERING DIVISION SUMMARY REPORT, JULY, AUGUST, SEPTEMBER, 1960. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 182p.

Chemical-Metallurgical Processing. The first of a series of demonstrations at high-activity levels of the melt-refining process for EBR-II core fuel was completed. An experiment was also completed on the evolution of fission-product krypton and xenon from an irradiated fuel pin as it was heated to a temperature above the melting point. In tests of alternate materials for use in a melt-refining furnace, a fibrous potassium titanate grain retainer was found to be a very effective heat insulator, but to have less strength than rigid Fiberfrax retainers. The skull remaining in the zirconia crucible after a melt-refining operation must be processed to recover, as partially purified metal, the fissionable material for return to the fuel cycle. Several essentially quantitative reductions of uranium dioxide and skull oxides were achieved in times of less than 8 hr at 800°C in dilute magnesium-zinc solutions and in magnesium containing a small percentage (0.5 to 2) of sodium as a wetting agent. Data and equations for solubilities of other elements in liquid cadmium are included. The partition coefficients of a number of representative fissile and fission product elements between the two immiscible liquids, lead and zinc, at about 735°C were measured. The free energy of formation of the uranium-thallium intermetallic compound UTl_3 was measured, using a galvanic cell method. Galvanic cell measurements with the cerium-zinc system at 443 to 742°C were also made. The determination of the heat of formation of zirconium tetrafluoride by combustions of zirconium in fluorine was completed. A value of −372.44 kcal/mole was obtained for the heat of formation of molybdenum hexafluoride. Calorimetric combustions of boron in fluorine are being continued. Exploratory combustions of magnesium, aluminum, zinc, and cadmium are being carried out. Fuel Cycle Application of Volatility and Fluidization Techniques. Investigation of the stoichiometry of the reaction of plutonium hexafluoride with sulfur tetrafluoride was completed. The investigation of the stoichiometry of the reactions of sulfur tetrafluoride with uranium trioxide, uranium dioxide, uranyl fluoride, and U_3O_8 was also completed. Radiation decomposition of plutonium hexafluoride in the presence of uranium hexafluoride at 2.6% per day, was found to be very similar to the value obtained for plutonium hexafluoride alone. In terms of wt.% hydrogen chloride, the solubility of hydrogen chloride in liquid hydrogen fluoride is 0.7 at −38°C and 2.4 at −78°C. An investigation of the corrosive effect of hydrogen fluoride-hydrogen chloride gas mixtures on A-nickel has been initiated. Additional studies of metal fluorinations were concerned with the mechanisms of the nickel-fluorine and nickel-oxygen reactions. Work continued on engineering-scale studies of the Direct Fluorination Process applied

to dense uranium dioxide pellet fuel. Decladding runs were made to investigate the effect of close packing of fuel elements on operation of the fluid-bed reactor. Mock-up tests of heat transfer from the surface of fixed packing submerged in a fluid bed were made to determine the effects of bed height and gas velocity. A final dissolution was performed in a series of dissolutions of synthetic fuel assemblies to demonstrate operation of the graphite pilot-plant dissolver. Examination of the walls of the graphite dissolver showed the expected presence of fused salt in the middle of the lampblack insulating zone. A fused-salt charge was allowed to freeze in the dissolver to determine the effect that this would have on dissolver components. Extensive damage to internal graphite downlines and heaters was found. Reactor Safety. In the continued study of the ignition of uranium it was confirmed that an aggregate or array of pieces ignites at a considerably lower temperature than an individual piece of the same specific area. Continued studies of the effects of halogenated hydrocarbons on the burning propagation of uranium and zirconium foils indicate the possibility of preventing continued combustion of individual zirconium foils or turnings thicker than 0.05 mm (2 mils). A self-consistent mechanism for the isothermal oxidation of uranium has been devised. The experimental program to determine rates of reaction of molten reactor fuel and cladding metals with water is continuing. A series of in-pile experiments was conducted in TREAT with oxide-core pins, cermet-core pins, and uranium wires. Reactor Chemistry. Neutron-capture cross sections for U^{238} were obtained for neutrons at 0.475 to 1.74 Mev. The Slurrex Reactor chemical supporting program was terminated and a final report is being written. In the Reactor Decontamination Program a study is being made with a stainless-steel loop that simulates the action of a boiling-water reactor into which mixed fission products can be introduced. It was found that the presence of oxygen during the contamination portion of an experiment reduced the effectiveness of decontamination by the alkaline permanganate-citrate procedure. Corrosion studies of various turbine materials in typical decontamination reagents were continued. Pitting of chromium-molybdenum steels in citrate solutions adjusted to pH 10 was found to be appreciably reduced when hexamethylenetetramine was added as an inhibitor. In the loop runs, radioactivity was introduced in the form of irradiated uranium which reacted with the hot water to simulate a fuel rupture. Analysis of loop liquid over a 12-day period indicated that the concentrations of uranium and fission products did not remain constant but exhibited variations both upward and downward. The fission products Zr^{95}, Ru^{103}, and Ba^{140}-La^{140} were deposited on the metal sample strip in the disengaging section in the same relative proportions as they were present in the circulating liquid. Cerium-141 deposition in the liquid phase was lower than that suggested by its relative content in the circulating liquid. (For preceding period see ANL-6183.) (J.R.D.)

12650 (ARGMA-TN-2H1N-26) RESEARCH LABORATORY QUARTERLY RESEARCH REVIEW NO. 26, MAY 1–JULY 31, 1960. (Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala.) Sept. 1, 1960. 65p.

Subjects covered in this report are materials, nuclear physics, fuels and combustion, physical electronics, and high-temperature physics. (auth)

12651 (ARGMA-TN-2H1N-27) RESEARCH LABORATORY QUARTERLY RESEARCH REVIEW NO. 27, 1 AUGUST–31 OCTOBER 1960. (Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala.). Dec. 1, 1960. 71p.

A description is given of the supporting research activities in the fields of materials, nuclear physics, fuels and combustion, physical electronics, and high-temperature physics. Investigations were made of the tensile properties of plastic films at high loading rates, a single shear sheet specimen for testing plastics, nozzle materials, neutron excitation functions, a sum-coincidence γ-ray scintillation spectrometer, combustion of n-butane with NF_3 + O_2 mixtures, combustion of n-C_4H_{10} with NF_3, millimeter wavelength radiometry, a simplified probe theory, and the identification and significance of the 4685.7 A line from plasmas. (For preceding period see ARGMA-TN-2H1N-26.) (B.O.G.)

12652 (MND-P-3009-1) SNAP PROGRAMS. Quarterly Progress Report No. 1 [for] October 22–December 31, 1959. (Martin Co. Nuclear Div., Baltimore). Nov. 1960. Contract AT(30-3)-217. 287p.

An analysis was made of the SNAP III generator to determine the cause of failure, and the test specifications were revised in line with the findings. During calibration and demonstration runs with the SNAP III-A generator, a leak developed in the valving mechanism of the variable heat-dump system. An examination disclosed that the valve was not satisfactory, so the generator was returned to the manufacturer for repair. A description is given of the generator, along with a performance evaluation program. A discussion is given of the work performed in advancing the technology of thermionic converters, specifically to increase efficiency by developing better emitter and collector materials and by reducing heat losses. Investigations were made in the areas of cesium diodes, effects of cesium on materials, electrical heaters, diffusion of gases through metals, and work function tests. Work done on the development of low-power thermionic generators included prototype development, heat-transfer studies and tests, vacuum tests in prototype shells, cathode and sapphire creep tests, a parametric study, the development of molybdenum fuel capsules, heliarc welding of molybdenum fuel capsules, hazards studies on Ce^{144} thermionic units, fabrication of a containment cask for Ce^{144} units, and fueling molybdenum capsules with Ce^{144} pellets. Investigations were made of the operational capabilities of SNAP-III type generators through tests simulating the anticipated environments to obtain information for conceptual designs to produce 2 to 5 watts of electrical power. Accomplishments in the development of a 1-watt nuclear power supply include the establishment of the over-all generator configuration, the sizing and arrangement of the Pu^{238} fuel, the analysis for helium pressure build-up within the fuel capsule, the selection and sizing of thermoelectric elements, a radiator design, the insulation arrangement, and the thermal analysis of the configuration. Work performed on the conceptual design of a 100-watt thermoelectric generator was devoted to heat-transfer analysis, isotope requirements, basic configuration design studies, selection and optimization of thermoelectric generator parameters, radiation shield design, evaluation of fuel containment problems under conditions of helium evolution, and the measurement of thermoelectric materials data. Analyses of heat-transfer and radiation shielding and studies of generator and component designs resulted in an optimum configuration for a 13-watt generator of the radiative-cylindrical type. The weight of the generator, exclusive of voltage regulation equipment, is ~8.6 lb; the over-all efficiency is 6.2%. Fuel-technology development studies were directed toward a parametric study of radioisotopes suitable for isotopic power, the feasibility of processing the selected isotopes, and the selection of purification procedures. (B.O.G.)

12653 (MND-P-3013-I) SNAP RADIOISOTOPE SPACE PROGRAMS, TASK 2, 3 AND 7, QUARTERLY PROGRESS REPORT NO. 5, OCTOBER 1 THROUGH DECEMBER 31, 1960. (Martin Co. Nuclear Div., Baltimore). Contract AT(30-3)-217. 46p.

Functional testing was completed on the ground handling equipment for transporting the Ce^{144} heat source container and loading the SNAP 1A generator. Mercury shield fill and drain tests for the generator system and the collar shield were conducted. Heat-transfer tests of the isotope heat source shipping cask were conducted. Simulated rocket-launch environmental tests of vibration, acceleration, and shock were completed on the G-2 generator. Analysis of the environmental test data was initiated. Final design studies for the G-3 generator were completed, and a thermoelectric module concept was selected for use in the isotope-fueled generator. Development tests of thermoelectric modules in a module tester were initiated. Voltage breakdown tests were conducted on a porcelain enamel spray coat. The material was evaluated for application to the G-3 generator inner skin as a possible second discrete barrier against hot junction electrical shorts. SNAP 3 generator 3M-1G10 completed 322 days of life test operation, and the power input was terminated after the generator was operated under a full range of external loads to obtain performance characteristics. Electrical power output after 322 days at steady-state heat source and external load conditions was 1.92 watts, for an over-all efficiency of 2.9%. Tear-down inspection of the generator confirmed previous indications of increased internal electrical resistance and thermal conductivity, which account for the gradual reduction in generator performance from the start-of-life electrical output of 3.45 watts and 5.2% over-all efficiency. The SNAP 3 3M-1G5 generator was successfully fueled with Po^{210}. Maximum electrical power output was 4 watts at an over-all efficiency of 5.2%. Radiological safety studies for space power were initiated. (For preceding period see MND-P-3012-I.) (auth)

12654 (NP-9367) PREVISIÓN DEL CONSUMO FUTURO DE RADIOISÓTOPOS EN EL PÁIS. Informe No. 36. (Prediction of Future Consumption of Radioisotopes. Report No. 36). N. Nussis (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). 1960. 23p.

A survey was made of the production and consumption of radioisotopes by various countries. Two types of data are tabulated: total annual consumption by isotope and annual consumption by isotope and by country. (W.L.H.)

12655 (NP-9734) REPORT ON THE ACTIVITIES OF THE DANISH ATOMIC ENERGY COMMISSION FOR THE PERIOD FROM 1 APRIL 1959 TO 31 MARCH 1960. (Denmark. Atomenergikommissionen, Roskilde). Dec. 1960. 70p.

The construction of the Risö Research Establishment was practically completed. The DR3 reached criticality on Jan. 17, 1960. An irradiation facility with a linear accelerator was completed during the summer of 1960. The operation of the DR1 and the DR2 is discussed. The second stage of the building program of the Agricultural Research Department was completed in 1959. A greenhouse for tracer experiments, a Co^{60} γ irradiation facility, and a small growth chamber designed to grow plants in an atmosphere of Co^{14}-labeled CO_2 were built. Experiments on physiological and genetic effects of γ irradiation in plants are outlined. Cooperative activities in the peaceful use of atomic energy are discussed. (C.H.)

12656 (NP-9863) ASTRONAUTICS INFORMATION. Open Literature Survey, Vol. III, No. 1 Entries 30,001–30,201. E. W. Barber, E. M. Carringer, M. G. Hoppe, and B. H. Nichols, comps. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Jan. 1961. Contract NASw-6. 34p.

A total of 200 references (entries 30,001 to 30,201 covering the period of Jan. 1961) is given on astronautics and associated fields. Most have appended short abstracts. (D.L.C.)

12657 (NP-9907) RESEARCH LABORATORIES SEMI-ANNUAL REPORT FOR THE PERIOD JANUARY–JUNE 1960. (Israel. Atomic Energy Commission, Tel-Aviv). 64p. (IA-601)

The Israel Research Reactor was brought to criticality after hazards analysis, operator training, and precriticality tests were completed. High-energy reactions of nuclei, absorption of mesons (K^-) in emulsions, and properties of mesonic atoms were investigated. Studies were made of the U–Al–Fe phase diagram. Selectivity in the anion exchange of metal complexes was investigated. Other experiments reported are: ion exchange studies of rare earths, absorption of uranium from acetate solutions by ion exchange, determination of anion exchangers suitable for work in fused salts, development of a method of focusing electrophoresis, extraction of hydrochloric acid into a third phase with TBP, behavior of ruthenium tetroxide in nitric acid solutions, properties of organic nitrogen oxides as ion exchangers and extractants, preparation of polysilanes, methods of spectrographic analysis of rare earths, chromatographic separation of the components of OPPA, determination of alcohols by a calorimetric method, polarographic determination of vanadium in phosphate rock, complexometric determination of aluminum in the presence of chromium, complexometric determination of sulfates, and determinations of halogens at low concentrations. The geochemical and radioactivity surveys of the Mishor-Chara and Neger areas were continued. A study was made of zinc distribution in various organs of the body. Blood volume was measured in patients with polycythemia vera treated with P^{32}. A method for the determination of plutonium in urine is outlined. Diagnostic advances in thyroid pathology due to scintillography are reported. Work of the Health Physics group is reported. (M.C.G.)

12658 (TID-5839) ATOMIC ENERGY COMMISSION—BUREAU OF MINES PROCESS HEAT REACTOR PROGRAM. Quarterly Progress Report, November 1, 1958 to January 31, 1959. L. L. Hirst, J. P. McGee, and G. R. Strimbeck (Bureau of Mines. Appalachian Experiment Station, Morgantown, W. Va.). 31p.

An evaluation of heat transfer tests performed in the atmospheric pressure loop showed that one test gave more consistent results, which was the result of the lower ratio of sphere diameter to bed diameter. Test runs were made on the 250-psig pressure loop to operate the loop at design conditions. High-temperature heat exchanger materials testing studies included: rupture strength determinations for Hastelloy-X and type-310 stainless steel at 2000 to 2200°F; studies of bond stability and temperature resistance of stainless-steel-clad molybdenum tubing; and the use of hydrogen to inhibit oxidation of molybdenum by steam. Urania-bearing graphite spheres were tested for stability under conditions of thermal cycling, and resistance to cracking caused by thermal shock. An electrically-heated tungsten filament was used to determine the oxygen concentration in helium. Tests were conducted to determine the effectiveness of porous stainless steel filters for the removal of dust from gases at elevated temperatures. (B.O.G.)

12659 (TID-5842) ATOMIC ENERGY COMMISSION–BUREAU OF MINES PROCESS HEAT REACTOR PROGRAM.

Quarterly Progress Report, November 1, 1959 to January 31, 1960. L. L. Hirst, J. P. McGee, G. R. Strimbeck, and H. H. Coates (Bureau of Mines, Morgantown, W. Va.). 18p.

Tests were made to check the reproducibility of readings from the high-velocity thermocouple (HVTC) and to determine the time necessary for heat saturation of the thermocouple. The new helium recycle compressor operated without difficulty for over 550 hours at 1000°F. Tests revealed that 5000 to 9000 ft^3 of helium per hour can be circulated through the loop at pressures of 100, 175, and 250 psig, and helium temperatures of 1600 and 2200°F. Results of tests with specimens of type-310 stainless-steel tubes, spray-coated with molybdenum and tungsten, indicate that the sprayed coatings provide no additional creep-rupture strength at 2000°F. An apparatus was constructed for life-testing promising commercially-available alloys for use in coal gasification. Tests are continuing with the tungsten tester to determine traces of oxidizing impurities in helium. The helium-heated gasifier was redesigned to accommodate higher pumping rates. In tests on the electrostatic precipitator at 900°F and 5 to 80 psig, more than 99% of the dust was removed from a gas flowing at 5 feet per second. (auth)

12660 (TID-5843) ATOMIC ENERGY COMMISSION—BUREAU OF MINES PROCESS HEAT REACTOR PROGRAM. Quarterly Progress Report, February 1 to April 30, 1960. L. L. Hirst, J. P. McGee, G. R. Strimbeck, and N. H. Coates (Bureau of Mines, Morgantown, W. Va.). 24p.

Tests were begun to determine helium heat-transfer coefficients at 1600 and 2200°F and 100, 175, and 250 psig. The helium film coefficient ranged from about 20 to 40 Btu/hr-ft^2-°F as the Reynolds number was increased from approximately 2300 to 6800. Frequent plugging of the gasifier coil has hindered attempts to continuously operate the life-test apparatus with lignite-water slurries. Other methods of feeding the lignite and steam were studied. Tests were made to determine the weight loss of porous carbon (for use in the ISR) in static and in flowing helium at 2150 to 2640°F. Investigations with the tungsten tester show that concentration of oxygen in the contaminant is the most significant variable that affects the tester in the analysis of oxidizing impurities in helium. The effects of H_2O, O_2, CO_2, and CO on the wolfram filament at 2500 and 3200°F were determined. Tests were begun with the redesigned coal gasifier heat-exchange section, but extended operating periods could not be attained because of plugging of the slurry preheater. Auxiliary heating devices were installed in the precipitator system so that tests can be conducted at temperatures of 1200 to 1500°F. (auth)

12661 (TID-8532) STUDY OF CONVENTIONAL STEAM POWER PLANTS CAPITAL AND ENERGY COSTS 44,000 AND 12,650 KW (GROSS) FOR UNITED STATES ATOMIC ENERGY COMMISSION, SAN FRANCISCO OPERATIONS OFFICE, BERKELEY, CALIFORNIA. (Kaiser Engineers Div., Henry J. Kaiser Co., Oakland, Calif.). Aug. 1, 1960. 85p.

This report may also be identified as KE-60-18.

Estimated capital and energy costs are presented of typical conventional fuel-fired power-generating plants with gross-rated electric capacities of 12,650 and 44,000 kw. The estimates are preliminary, based on conceptual designs. They were prepared for comparison with the costs of nuclear-reactor power plants of similar size. The conventional steam power plants were designed as single-boiler turbine-generator plants to be comparable with the nuclear-reactor power plants which will each consist of a single-reactor turbine-generator unit. A general description of the conventional power plants is presented. Capital and energy cost estimates are presented. Summaries are given of the construction cost estimates; the annual and unit power costs computed on investor-owned and REA-financed public-utility bases, respectively; and plant design information. General arrangement and outline drawings were prepared for each of the conventional power plants for the alternative fuels considered. The general arrangement of the natural-gas-fired plants is very similar to that of the oil-fired installation except for the elimination of fuel storage tanks. (auth)

12662 (TID-8533) STUDY OF NUCLEAR POWER PLANTS CAPITAL AND POWER GENERATION COSTS 44 AND 12.65 MWE (GROSS) FOR UNITED STATES ATOMIC ENERGY COMMISSION, SAN FRANCISCO OPERATIONS OFFICE, BERKELEY, CALIFORNIA. (Kaiser Engineers Div., Henry J. Kaiser Co., Oakland, Calif.). Oct. 31, 1960. 190p.

This report may also be identified as KE-60-19.

Results of studies to develop basic parameters are presented for normalization of reactor capital cost, fuel cycle cost, and operation and maintenance cost. Included are estimates of capital and power generation costs for central station nuclear power plants with gross-rated capacities of 12.65 and 44 Mw(e). Data are presented for pressurized-water, boiling-water, organic-cooled, sodium-graphite, and sodium-fast reactor concepts. Also included are data for heavy-water reactors and helium-cooled graphite-moderated reactors. (J.R.D.)

12663 (TID-8534) STUDY OF CONVENTIONAL PROCESS STEAM PLANTS CAPITAL AND STEAM PRODUCTION COSTS 125,000 POUNDS PER HOUR (40 MWT) FOR UNITED STATES ATOMIC ENERGY COMMISSION, SAN FRANCISCO OPERATIONS OFFICE, BERKELEY, CALIFORNIA. (Kaiser Engineers Div., Henry J. Kaiser Co., Oakland, Calif.). Oct. 31, 1960. 38p.

This report may also be identified as Ke-60-20.

An attempt was made to determine the estimated capital and production costs of typical conventional fuel-fired steam generating plants for industrial process applications, with a net rated output of 125,000 lb/hr (40 Mw(t)), for comparison with the costs of nuclear reactor steam generating plants of similar size. In general, capital cost estimates were based on labor and material prices in effect on June 30, 1960, with no allowance for escalation; identical percentages were applied for indirect construction costs for conventional steam generating plants as for nuclear steam generating plants; and production costs were based on an annual plant operating factor of 90%. The conventional process steam generating plants were designed as single boiler units, to be installed as an addition to an existing process steam generating facility in an industrial complex. Thus the conventional plants are comparable with the nuclear reactor process steam generating plants which were designed on a similar basis. A general description of the conventional steam plant is presented. Capital and production cost estimates are given. The construction cost estimates, and the estimated production costs are summarized. General arrangement drawings and heat balances for the steam generating plants were prepared, based on use of alternative fuels: coal, oil, and natural gas. The natural gas-fired and oil-fired plants are generally similar, with the exception of the additional fuel storage facilities provided for the oil-fired plants. (auth)

12664 (UCRL-6274) FINAL REPORT ON THE PINOT EXPERIMENT. Frank L. Adelman, Clifford M. Bacigalupi, and Floyd F. Momyer (California. Univ., Livermore.

Lawrence Radiation Lab.). Dec. 27, 1960. Contract W-7405-eng-48. 21p.

The Pinot Project was designed to provide some indication of the extent to which gases from a confined underground explosion in oil shale would migrate parallel to the bedding planes. At 0800 on Aug. 2, 1960, 946 lb of nitromethane was fired in shot hole No. 1. There was no visible damage to the mine adit or to any structure associated with the workings. Gas samples collected from sampling holes near the shot hole were analyzed for Kr^{85}, which had been included with the nitromethane as a tracer. It appeared that the Kr^{85} concentration in the samples out to 50 ft was more or less independent of space and time between +2 and +50 hr. Relatively little Kr^{85} was detected at 125 ft and none beyond. About $(20 \pm 10)\%$ of the Kr^{85} escaped into the adit. The results of the Pinot experiment cannot be extrapolated quantitatively to the case of a nuclear explosion in oil shale. Even if the structure at the Pinot site is typical of oil shale, the generation of a smaller quantity of noncondensible gases per unit energy in a nuclear explosion (as compared with a chemical explosion), the shorter time scale of the energy release and the higher temperatures and pressures encountered will all have a definite influence on the effective containment distance. One can conclude, however, that, if the medium at the site of a potential nuclear experiment is similar to that at Pinot, the radioactive gases will not travel preferentially in directions parallel to the bedding planes, but rather will tend to expand more or less spherically from the shot point. In other words, an explosion in oil shale designed not to vent in a direction perpendicular to the bedding planes will be just as tight parallel to the bedding planes. (auth)

12665 (AEC-tr-4479) PROSPECTS OF NUCLEAR POWER DEVELOPMENT AND WORLD TRENDS IN ELECTRIC POWER GENERATION COST. Rudolf Pomerski. Excerpt Translation by J. Woroncow (General Electric Co. Aircraft Nuclear Propulsion Dept.) from Nukleonika, 4: No. 6, 639-53(1959). 6p. (XDC-61-1-110).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 15496.

12666 (CEA-tr-A-849) ASPECTS ÉCONOMIQUES ET SOCIAUX DE L'UTILISATION DE L'ÉNERGIE NUCLÉAIRE. (Economic and Social Aspects in Utilization of Nuclear Energy). G. Friedrichs. Translated into French from Zweite Reaktortagung der Studiengesellschaft zur Förderung der Kernenergieverwertung in Schiffbau und Schiffahrt, Kongress bei Hamburg, 25-28 November, 1959. 17p.

An attempt is made at showing the economic and social effects of nuclear technology, now and in the future. The discussion includes reactors, radiation, isotopes, economic aspects, and political, economic, and social problems. (T.R.H.)

12667 DRILLING INTO MOLTEN LAVA IN THE KILAUEA IKI VOLCANIC CRATER, HAWAII. D. E. Rawson (Univ. of California, Livermore). Nature, 188: 930-1 (Dec. 10, 1960). (UCRL-6129)

An experiment was conducted to obtain knowledge of the problems encountered when drilling through the crust of a lava lake into molten rock. The experiment demonstrated that it is possible to drill into hard rock at temperatures up to 850°C with standard core-drilling equipment, using compressed air to cool the rock and remove the cuttings. By using water to cool the rock and drilling with water periodically injected into the compressed air line, it was possible to drill into rock that was at temperatures exceeding 1050°C. A thermocouple package was installed in pipe at three points in the lava lake crust to study the cooling history. Complete chemical and petrographic analyses on the core and melt are planned. (M.C.G.)

12668 ATOMIC ENERGY LEGISLATION THROUGH 86TH CONGRESS, 2ND SESSION. (United States. Congress. Joint Committee on Atomic Energy). Dec. 1960. 258p. (GPO)

Atomic energy legislation through the 2nd session of the 86th Congress is presented. Included are the Atomic Energy Act of 1954, as amended, AEC Authorization Acts, the Euratom Cooperation Act of 1959 and concurrent resolution, and the International Atomic Energy Agency Participation Act of 1957. The appendixes include the Atomic Energy Act of 1946, as amended; indexes to the legislative history of the 1946 and 1954 acts and cross references; appropriations for 1947 to 1961; and other laws and authorizations. (M.C.G.)

12669 BERICHTE ZUR ATOMKERNENERGIE. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Reports on Atomic Energy. Bibliographic Compilation). (Gmelin-Institut für Anorganische Chemie und Grenzgebiete, Frankfurt am Main). Jan. 1, 1961. 104p. (AED-BRD-A-1961-1)

A bibliographic listing of the reports issued by various atomic energy agencies over the world is presented. A subject index and a report number index are included. (About 360 references). (T.R.H.)

12670 GÉNIE ATOMIQUE. Tome Premier. (Atomic Engineering. Volume I). Saclay, France, Institut National des Sciences et Techniques Nucléaires and Paris, Presses Universitaires de France, 1960. 950p. NF. 190.

The first of a four-volume set of handbooks is presented. The other three volumes deal with electronics and reactor operation, reactors, and nuclear materials. This volume is divided into sections on nuclear physics generalities, neutrons in reactors, and protection against radiation. Section one deals with mathematics, structure of matter, mass, energy, radioactivity, the neutron, kinetic theory of gases, passage of particles and radiation through matter, nuclear reactions, and nuclear fission. Section two deals with neutron diffusion and slowing down, multiplying media, criticality, reactor kinetics, plutonium production, critical and exponential experiments, effects of xenon and samarium, control, and calculations. The third part covers biological effects of radiation, danger of radiation and toxicity of radioactive materials, organization for radiation protection, standards, aerosols and radioactive gases, radiation detection, and safety of atomic installations. (T.R.H.)

12671 GÉNIE ATOMIQUE. Tome Deux. (Atomic Engineering. Volume II). Saclay, France, Institut National des Sciences et Techniques Nucléaires and Paris, Presses Universitaires de France, 1960. 1140p. NF. 210.

An extensive treatment is given to radiation detection, detectors, pulse techniques, radioprospecting, measurement of reactor parameters, cladding rupture detection, and electronics in nuclear chemical plants. (T.R.H.)

12672 GUIDE TO THE SUBJECT SCOPE OF THE ENGINEERING MATERIALS PROGRAM. Francis L. Sachs and Richard E. C. Duthie, comps. (Office of Technical Information Extension, AEC). Jan. 1961. 24p. (TID-4553 (2nd Ed.)).

The guide describes the scope of the AEC engineering materials program. Seventeen categories are defined, and their scopes are explained by examples. The guide is designed to assist AEC contractors in selecting engineering materials for transmittal to the Office of Technical Information Extension, Oak Ridge, Tennessee, for cataloging and dissemination. It contains instructions for submitting these materials. (auth)

12673 MAJOR ACTIVITIES IN THE ATOMIC ENERGY PROGRAMS, JANUARY–DECEMBER 1960. (Atomic Energy Commission, Washington, D. C.). 553p.

The AEC's annual report to congress for 1960 is presented in two parts. Part One surveys industry and commission activities, the civilian nuclear power program, and programs in support of industry. Part Two summarizes major activities in relation to raw materials, special nuclear materials, military applications, weapons test negotiations and related research, military reactor development, civil uses of nuclear explosives, physical research, biology and medicine, radioisotope and radiation development, international work, legal matters, classification, information, education and training, health and safety, nuclear materials management, construction and supply, community and industrial relations, and organization and personnel. (B.O.G.)

BIOLOGY AND MEDICINE

General and Miscellaneous

12674 (ANL-6264) BIOLOGICAL AND MEDICAL RESEARCH DIVISION SEMIANNUAL REPORT, JULY THROUGH DECEMBER, 1959. (Argonne National Lab., Ill.). Dec. 1960. Contract W-31-109-eng-38. 189p.

Progress is reported on the following studies: the possible relationship between environmental Ra^{226} and incidence of bone tumors in human populations; the incidence of tumors in mice exposed to chronic γ irradiation; the effects of chronic γ irradiation on histology of testes cells; the effects of periodic exposure to γ radiation on the mortality of guinea pigs; determinations of the density of various mouse tissues; the synthesis of dimethyl formamide (DMF) and uranyl nitrate-DMF; an investigation of the role of the small intestine in acute radiation death in mice following exposure to fast neutrons or γ radiation; the effect of neutron dose on the incidence of mammary tumors and fertility of female rats and mice; measurements of Cs^{137} in samples of tea and human milk made with a γ spectrometer; the latency and growth of bone tumors induced by injected Sr^{90} in two strains of mice; histopathologic changes in the skeleton of mice following injection of various doses of Ra^{226}; the development of mathematical models of cellular populations; reaction mechanisms in the response of chicks to radiation injuries; cell generation times in E. coli; the demonstration of infective organisms living in the cytoplasm of A. proteus; electron microscopic study of the fine structure of fat cells as related to structure; the effects of enzymes on induction of bacteriophage of E. coli; lipid metabolism and the isolation, fractionation, and analysis of cholesterol esters obtained during turnover studies; tracer studies on the role of urea in nitrogen metabolism using deuterium-labeled urea in which free energies of formation for deutero-urea were determined; the participation of metal ions in transmethylation activity of enzymes in microorganisms; the effects of ultraviolet irradiation on yeast cells; the effects of thiol compounds on mitochondrial swelling; the effects of photoperiodism on flowering of xanthium; the effects of concentrations of 30 to 50% of deuterium oxide in drinking water on cells of male reproductive organs in mice and dogs and reproductive potential of male mice; the use of tritiated thymidine as a tracer in cell renewal in acute and chronic myelogenous leukemia; the loss of mutagenic potential in chemostat cultures of E. coli; radioinduced recessive mutations in mice; the demonstration of a recessive mutation in Drosophila; the pathology of ectromelia (a virus disease) and pseudomonas infections in mice; the effects of x, γ, and neutron irradiation on the formation of bacterial endotoxins in mice; the radioprotective effects of injected protoplasm in amoebae; the effects of chelating agents on the removal of monomeric and polymeric thorium in rats; the relationship of plutonium removal to tumor incidence in mice; the effects of chelating agents on the removal of monomeric and polymeric plutonium in mice; and the use of tritiated thymidine to measure the growth of tumor metastases in mice. A list of publications during the period is included. (For preceding period see ANL-6200.) (C.H.)

12675 (NP-9898) THERMAL AND RADIATION INJURY. Final Report for period covered July 1, 1949–May 31, 1959. (Medical Coll. of Virginia, Richmond). Contract DA-49-007-MD-99. 23p.

Results are summarized from a 10-year study on the pathology and treatment of burns induced by exposure to thermal and ionizing radiations. Accomplishments include the development of the Evans' Formula for estimation of fluid requirements following thermal injury; the development of a dressing for burns; the elaboration of the syndrome of pseudodiabetes of stress; delineation of the effects of burn injury plus total-body exposure to ionizing radiations; comprehensive studies on the cause of the anemia of thermal burns; characterization of the light energy required to produce different depths of flash burn in humans; observations on the adrenocortical response to thermal injury; observations on the adrenomedullary response to thermal injury; the characterization of a syndrome of adrenomedullary response to thermal injury; and studies of the nutritional requirements of severe burns according to age and sex. A list is included of publications covering the various phases of the study. (C.H.)

12676 (SCTM-331-60(14)) THE RELATIONSHIP OF SKIN CONDUCTANCE TO BEHAVIOR IN A VIGILANCE TASK. David Stea (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 51p.

The investigation of a potential autonomic physiological concomitant of overt behavior (i.e., galvanic skin response as a correlate of signal detection) in a Mackworth type vigilance task is described. Previous activity in this general area is discussed, and several new approaches are indicated. The present study differs from previous studies in that more sophisticated equipment and a larger number of subjects were used in order to more exhaustively test the major hypothesis that a relationship exists between the galvanic skin response (GSR) and vigilance. Although this study indicates that GSB is a gross concomitant of vigilance and that one GSR measure, the number of responses per unit time, may be a predictor of a given subject's over-all level of vigilance, there is still no evidence that the fluctuations that invariably occur in the efficiency of a subject's performance of a vigilance task can be predicted from basal skin conductance. (auth)

12677 (TID-12105) BIOLOGICAL, CHEMICAL AND RADIOCHEMICAL STUDIES OF MARINE PLANKTON. Progress Report for the Period January 1–December 31, 1960. Appendix B to Reference No. 61-6. (Woods Hole Oceanographic Institution, Mass.). Feb. 15, 1961. Contract AT(30-1)-1918. 178p.

Procedures are described for the determination of total and carbonate carbon in marine plankton. Data are included from studies of the physiological ecology of a marine diatom, Skeletonema costatum; the identification of a new calanoid copepod, Candacia ketchumi, from the Sargasso Sea; an analysis of zooplankton collected between New York and Bermuda; the horizontal distribution of phytoplankton; the distribution of phytoplankton species with respect to salinity and other variables between the coast of New England and Bermuda; the persistence of

winter water on the continental shelf south of Long Island, N. Y.; the rate of phosphorus uptake and exchange by Phaeodactylum tricornutum; the applications of observations of vertical and horizontal distributions of radioactive rare earths from fall-out in geochemical and hydrodynamic studies of the Atlantic Ocean; nitrification by marine organisms; the environmental physiology of marine phytoplankton; measurements of the distribution of chlorophyll, phosphorus, and dissolved oxygen in the Red Sea; and the interrelation of water-soluble yellow substances and chloroplastic pigments in marine algae. (C.H.)

12678 (TID-12109) GENETICS OF NATURAL POPULATIONS. XXVIII. THE MAGNITUDE OF THE GENETIC LOAD IN POPULATIONS OF DROSOPHILA PSEUDOOBSCURA. B. Spassky, N. Spassky, O. Pavlovsky, M. G. Krimbas, C. Krimbas, and Th. Dobzhansky (Columbia Univ., New York). [nd]. Contract AT(30-1)-1151. 39p.

Results are reviewed from previous studies on genetic loads in Drosophila. A series of studies was made on Drosophila pseudoobscura to determine whether individuals carrying different combinations of chromosomes are phenotypically uniform or heterogeneous, and if heterogeneous, whether or not the heterogeneity is correlated with the effects of the component chromosomes in homozygotes. The magnitude of the genetic loads carried in the second and third chromosomes of Drosophila pseudoobscura were estimated for samples from populations living near Austin, Tex., and Mather, Calif. The effects of the chromosomes on the viability of the homozygotes were found to differ in cultures raised at 25 and at 15°C. Data are tabulated. A negative correlation between viability and variability was observed for both homozygotes and heterozygotes. (C.H.)

12679 (TID-12115) HOW STABLE IS BALANCED POLYMORPHISM? Theodosius Dobzhansky and Olga Pavlovsky (Columbia Univ., New York). Dec. 1959. 16p.

Results are reported from studies on the stability of balanced polymorphism in populations of Drosophila paulestorum and Drosophila willistoni. These populations naturally contain more than 50% heterozygotes for certain inversions. Data are tabulated. It was concluded that these populations did not possess genetic materials from which monomorphic genetic systems conferring high adaptedness could be built. The evolutionary advantages of genetic systems based on balanced polymorphisms are discussed. (C.H.)

12680 (TID-12116) GENETICS OF NATURAL POPULATIONS. XXIX. IS THE GENETIC LOAD IN DROSOPHILA PSEUDOOBSCURA A MUTATIONAL OR A BALANCED LOAD? Th. Dobzhansky, C. Krimbas, and M. G. Krimbase (Columbia Univ., New York). [1961]. Contract AT(30-1)-1151. 17p.

The mutational component of a genetic load consists of genetic variants and a balanced component. The genetic variants reduce the fitness of their homozygous, or of both homozygous and heterozygous carriers, in most environments. The balanced component of the load consists of heterotic genes and gene complexes, which yield highly fit heterozygotes but relatively less well adapted homozygotes. Balanced loads are maintained primarily by natural selection. The role of the genetic load was studied in populations of Drosophila pseudoobscura. Data are tabulated and discussed. (C.H.)

12681 (TID-12117) RELEASE OF GENETIC VARIABILITY THROUGH RECOMBINATION. V. BREAKUP OF SYNTHETIC LETHALS BY CROSSING OVER IN DROSOPHILA PSEUDOOBSCURA. Theodosius Dobzhansky and Boris Spassky (Columbia Univ., New York). [1961]. Contract AT(30-1)-1151. 17p.

Results are reported from a series of studies on the mechanisms that maintain genetic diversity in Mendelian populations in which three species of Drosophila were used. Samples of chromosomes taken from the natural populations were tested for viability effects in homozygous conditions. From these samples 20 chromosomes were selected in each species, and the strains containing the 20 selected chromosomes were intercrossed in all possible combinations. A total of 1900 recombination chromosomes per species resulted, which were then tested for their viability effects in the homozygous condition. The viability of the homozygotes for the recombination chromosomes varied all the way from normal and subvital to semilethal and complete lethality. Data are tabulated and discussed. (C.H.)

12682 THE EFFECT OF DEUTERIUM OXIDE ON ASCITES TUMOR GROWTH IN MICE. Asher J. Finkel and Dorice M. Czajka (Argonne National Lab., Ill.). Ann. N. Y. Acad. Sci., 84: 755-62(Nov. 25, 1960).

The growth of Krebs-2A ascites tumors in mice was appreciably depressed by the presence of deuterium in the body fluids in concentrations ranging from 13 to 32%. Measurement of the glutamic oxalacetic transaminase (GO-T) levels revealed that with increasing deuteration there was a progressive elevation of serum GO-T in tumor-bearing mice and an even more rapid rise of ascitic plasma GO-T. These data suggest that deuteration of the organism leads to tumor-cell injury with resulting release of GO-T into the ascitic fluid, whence it is carried into the general circulation. The notion that deuterium injures and possibly destroys mouse ascites tumor cells is supported, in part, by the terminal increase in the incidence of eosinstainable tumor cells, and, in part, by the absence of any striking difference in mitotic index of deuterated and nondeuterated tumor cells. These conclusions properly apply to transplantable mouse ascites tumors, and they may or may not be applicable to other biological material. (auth)

12683 SEX-LINKED RECESSIVE LETHALS IN DROSOPHILA WHOSE EXPRESSION IS SUPPRESSED BY THE Y CHROMOSOME. D. L. Lindsley, C. W. Edington, and E. S. Von Halle (Oak Ridge National Lab., Tenn.). Genetics, 45: 1649-70(Dec. 1960). (A/AC.82/G/L.431)

A method was devised which allows the detection and recovery of sex-linked recessive lethals with lethal phenotype that is suppressed by the Y chromosome, as well as orthodox lethals that are inviable with or without a Y. With doses of 3 and 4 kr, approximately 20% of all induced sex-linked recessive lethals survive in the presence of a Y chromosome and are consequently overlooked by currently used methods of lethal detection. The Y-suppressed lethals may be divided into two major classes. About one-eighth of them are deficiencies for the proximal heterochromatin, specifically for bb^+, and they are suppressed by the Y because the Y carries the homologous region. The other seven-eighths are nearly all associated with gross rearrangements with at least one break point in the chromocentral heterochromatin and at least one in the X. These are concluded to be variegated position-effect lethals. The V-type position-effect lethals may be further subdivided into one group that is male fertile and associated with X chromosome inversions or insertional translocations and another group that is male sterile and associated with reciprocal translocations with a break in the X and a break in the chromocentral heterochromatin of chromosome 2 or 3. The sterility of the reciprocal translocations is attributable to failure of sperm head elongation. It is postulated

that continuity of the X chromosome plays an important role in normal spermiogenesis and that this continuity is disrupted by reciprocal translocation. (auth)

12684 TRANSLOCATIONS BETWEEN THE X AND THE Y CHROMOSOMES OF DROSOPHILA MELANOGASTER. Benedetto Nicoletti and Dan L. Lindsley (Oak Ridge National Lab., Tenn.). Genetics, 45: 1705-22(Dec. 1960).

A sample of 86 T(X;Y)'s was recovered from irradiated X/Y sperm and a cytological and genetic analysis performed. The results of this analysis are tabulated and discussed. (C.H.)

12685 ESSENTIAL OIL SYNTHESIS IN MINT. R. H. Reitsema, F. J. Cramer, N. J. Scully, and W. Chorney (A. M. Todd Co., Kalamazoo, Mich. and Argonne National Lab., Ill.). J. Pharm. Sci., 50: 18-21(Jan. 1961).

Labeling pepermint oil by growth of the plants under an atmosphere containing $C^{14}O_2$ has permitted study of some phases of the biochemistry of essential oils. It was found that oil is synthesized from carbon dioxide in detectable amounts in less than 15 min. Production of peppermint oil continues for several hours in the dark and is not stopped by cessation of photosynthesis. The loss of oil from the plant to the air is very large. Infiltration experiments were investigated as an alternate way to introduce radioactivity. Menthol was obtained from menthone. Several compounds, including oxygenated terpenes, were produced from terpene hydrocarbons. (auth)

12686 Sr^{90} EXCHANGE IN THE SKELETON OF DOGS IN REMOTE PERIODS. Yu. D. Parfenov. Med. Radiol., 5: No. 12, 43-7(Dec. 1960). (In Russian)

For 3½ years a study was made of the dynamics of changes of activity concentrations in the diaphysis, metaphysis and epiphysis of the femur, rib and parietal bone of adult dogs following single intravenous administration of Sr^{90} (0.1, 0.15, 0.2 and 0.4 mc/gm). On the basis of experimental data obtained an assessment was made of Sr^{90} exchange in the skeleton. A detailed description of the method of obtaining the equation exchange and the results thereof are given. (auth)

12687 THE POSSIBILITY OF THERAPEUTIC APPLICATIONS OF BEAMS OF NEGATIVE π-MESONS. P. H. Fowler and D. H. Perkins (Univ. of Bristol, Eng.). Nature, 189: 524-8(Feb. 18, 1961).

The possibility of using beams of negative π mesons for the treatment of tumors is considered. Possible advantages of pion beams are considered. Biological tissue is made up of hydrogen, carbon, nitrogen, and oxygen. When a π-meson is brought to rest in such a medium it may be captured by any one of these atoms. When captured by hydrogen the resulting mesic atom migrates a short distance in the tissue until it encounters a heavier nucleus to which the π^- is transferred. As a result, all the mesons interact before decaying with one or another of the nuclei C^{12}, N^{14} or O^{16}. In such interactions, about 20% of the total rest-energy of the meson, that is about 30 Mev, appears in the form of α particles and protons, nearly all of which have ranges less than 1 mm in biological materials. A further 40 Mev is expended in breaking up the nucleus, and the remaining 70 Mev is carried off as fast particles, mostly neutrons, of which about 60 or 70% will escape from the tissue without interacting. Advantages of using beams of negative π-mesons in the treatment of tumors are based on the fact that meson capture by light elements, especially C^{12} and O^{16}, leads to an exceptionally large release of energy in the form of short-range α particles. The range of a π^- meson of 52 Mev is about 10 cm in biological tissue, the maximum depth at which it is commonly necessary to irradiate tumors in the human body. If such a beam is homogeneous in energy, there will be a straggling in range of about 2.5 mm. The advantages of such a beam are illustrated by a calculated radiation field due to an initially parallel beam of 52 Mev. Results are compared with the computed field due to γ rays. Available data on biological effects and dosimetry are reviewed. For a beam of π^- mesons, the damage per unit volume is many times greater in the tumor than in adjoining regions, and the total damage in the tumor region appreciably exceeds that in the whole of the surrounding body tissue. The advantages appear to be very great. (C.H.)

12688 ABSORPTION OF INHALED RADIOACTIVE WATER VAPOUR. J. B. West and C. T. Dollery (Hammersmith Hospital, London). Nature, 189: 588(Feb. 18, 1961).

Three normal volunteers inhaled two breaths each of air containing 2% water vapor labeled with O^{15}. The activity of the lungs and respiratory tract was detected by two pairs of scintillation counters connected in coincidence. Counting fields included the mouth, pharynx, trachea, and peripheral lung fields. Data are tabulated on the counting rates after a typical breath. Methods used in the preparation of the labeled water vapor are described. (C.H.)

12689 ACCIDENTAL RADIOACTIVE LABELLING OF A MIGRATORY MOTH. H. B. D. Kettlewell (Univ. of Oxford) and M. J. Heard. Nature, 189: 676-7(Feb. 25, 1961).

Following the explosion of two atomic weapons in North Africa in Feb. 1960, a survey was made of the radioactivity of insects collected in Great Britain. An effort was made to determine whether certain migratory moths, which arrive in Great Britain in the early months of the year, had flown directly from the African Continent. One specimen of the moth Nomophila noctuella was found which contained a single radioactive particle that originated in the Sahara test. The evidence suggests, but not conclusively, that insects as small as this moth can cover a distance of approximately 1,500 miles in the course of their short lives. (C.H.)

12690 A TECHNIQUE FOR DESTRUCTION OF THE PINEAL BODY USING YTTRIUM-90 SPHERES. Uno Holmgren (Univ. of Uppsala) and Gustaf Notter. Nature, 189: 773-4(Mar. 4, 1961).

A technique is described for the destruction of the pineal body in rats by radiation from implanted Y^{90} spheres. (C.H.)

12691 STUDY AND CHECKING OF THE LABELLING OF RED BLOOD CORPUSCLES WITH CHROMIUM-51. Yves Cohen and Jacques Ingrand (Centre d'Etudes Nucleaires, Saclay, France). Rev. hematol., 15: 217-32 (1960). (CEA-1618). (In French)

The biological checking of Cr^{51} has been based on an extensive experimental study which has brought to light the importance of certain factors, i.e., the presence of trivalent chromium in the solution of sodium chromate Cr^{51}, the progression of trivalent chromium from the soluble to the insoluble form, the pH of the solutions, and the preservation period of the solutions. These factors are involved in the biological labeling of red blood cells, in the apparent value of the blood volume, in the lifetime of self-transfused red cells. These investigations, carried out on rabbits, have enabled the establishment of the physicochemical characteristics of radioactive sodium chromate solutions destined for the diagnosis of hematological diseases in man. The experiments, explained in detail, provide an original contribution which should prove useful to researchers and hematologists. (auth)

12692 PIERWSZE KRAJOWE SYMPOZJUM POSWIECONE STOSOWANIU IZOTOPOW PROMIENIOTWORCZYCH, W BIOLOGII, MEDYCYNIE, I ROLNICTWIE, 2 I 3 KWIETNIA

1959, WARSZAWA. (First National Conference on Use of Radioisotopes in Biology, Medicine, and Agriculture, Warsaw, April 2-3, 1959). Warsaw, Bureau of the Atomic Energy Ministry, 1959. 699-843p.

Eighty-two papers are included on such topics as tracer techniques, fall-out distribution and accumulation, and detection and measurement of radioactivity. Separate abstracts have been prepared for six papers. (D.E.B.)

Biochemistry, Nutrition, and Toxicology

12693 (NYO-9628) EFFECTS OF DEUTERIUM ON NORMAL AND VIRUS-INFECTED TISSUE CULTURE CELLS. Final Report for Period January 1, 1959–December 31, 1960. David Kirtchevsky (Wistar Inst. of Anatomy and Biology, Philadelphia). [1960?]. Contract AT(30-1)-2299. 14p.

The effect of D_2O on the growth of three stable mammalian cell lines (HeLa, L, and L-5178Y) was investigated. As D_2O concentration is increased, all cells show an increased water content and dry weight and a decreased growth rate. Cytologically an increase is seen in the number of multinucleated cells and sudanophilic material. Chemical investigation of the three stable D_2O-grown cell lines shows a decrease in phosphorus compounds of all types and in ribose compounds. An increase in total glyceride, a questionable increase in ester sterol in L5178Y and L, and a decrease in free sterol are noted. In HeLa, a definite increase in ester sterol and a questionable change in free sterol are seen. Swiss mice were maintained on a regimen of 25% D_2O for three weeks. The mice were slightly smaller than H_2O-fed controls, but the liver weight/body weight ratio was greater. There were no significant differences in liver lipid or cholesterol. Histologic examination showed progressive vacuolization and loss of basophilia, with changes in the mitochondrial distribution in the cytoplasm. These alterations did not show any specific localization in the hepatic lobule. There was a progressive reduction in the ability of liver homogenates from D_2O-fed mice to convert acetate-2-C-14 to cholesterol and fatty acid. Incubation of normal mouse livers in media containing 75% D_2O resulted in significant enhancement of cholesterol and fatty acid biosynthetic capacity. The reduced lipogenesis in D_2O-fed mice appears to be due to derangements in cell structure, rather than to inhibition of enzyme activity. The effect of D_2O on bacteriophage replication was examined. The burst size of T5 was somewhat reduced in deuterated E. coli, but the burst size of T7 was significantly increased. These differences might be explained by the fact that although the bulk of T5 DNA is derived from the medium, most of the T7 DNA is derived from the host. With increased size of the host, more DNA and protein production might be expected. Studies of the multiplication of poliovirus in deuterated HeLa and monkey kidney cells show a marked increase in burst size. An attenuated type 1 polio virus (CHAT) that does not normally multiply at elevated temperatures will do so in deuterated media. This strain of polio will also grow well on stable lines of monkey kidney in deuterated media; in aqueous media the growth of CHAT on this cell line is very poor. (auth)

12694 (TID-11883) METABOLISM OF SELENIUM AND SULFUR IN PLANTS. Final Report, July 1, 1950–October 31, 1960. E. I. Whitehead (South Dakota State Coll., Brookins). Contract AT(11-1)-97. 49p.

Results are summarized from a series of studies on the metabolism of selenium and sulfur by plants. Se^{75} was used as a tracer in studies on the toxic effects of selenium in wheat plants and the effects of the form of selenium supplied in the soil and degree of maturity of the plants on results. The volatility of selenium in plant and animal tissues was studied, using Se^{75} as a tracer. Arsenic was found to delay the uptake of selenium by rat tissues and to decrease selenium exhalation. The effect of microbial metabolism on the evolution of volatile selenium from soil was determined. Protein fractions of wheat plants, grown on soil containing trace amounts of Se^{75}, were separated chromatographically on starch columns, and the selenium contents were determined. Results are included from tracer studies on the substitution of selenium for sulfur in amino acids synthesized by wheat plants; the effects of selenate, selenite, sulfate, and phosphate on the uptake of S^{35}, Se^{75}, and P^{32} by wheat plants; the toxic effects of arsenite, arsenate, selenite, and selenate on the growth of Saccharomyces cerevisae; and the effect of sulfur sources on the growth of Neurospora crassa cultured with selenite. (C.H.)

12695 (TID-11937) THE ACCUMULATION OF MINERAL ELEMENTS BY NATIVE PLANTS. Progress Report. John T. Curtis and Gerald C. Gerloff (Wisconsin. Univ., Madison). [nd]. Contract AT(11-1)-788. 28p.

Progress is reported in a study on the accumulation of mineral elements by native plants. Samples of plant material were analyzed by chemical and spectrographic techniques. Results are summarized from approximately 2700 individual analyses. Analyses for trace elements were carried out, as well as for the more abundant elements. Some of the interesting possibilities indicated by the preliminary analytical work are discussed. Unusually high concentrations of an element in a single or in a few species in a community are of interest in indicating a selective capacity for uptake. Mechanisms involved in such selective uptake, particularly of trace elements, are considered. It is postulated that correlations in the concentrations of the elements in the samples may be of significance in indicating antagonisms or synergisms in plant nutrition. Tentative conclusions are drawn, based on the incomplete data, on both the species and community levels. Data are tabulated for individual plants and community aspects of mineral accumulation. Results are included from laboratory studies on the toxic effects of manganese in plants and the selective distribution of sodium between plant roots and shoots. (C.H.)

12696 (TID-12133) STUDY OF THE CONDENSING UNITS IN NUCLEIC ACID BIOSYNTHESIS. Report of Activities for June 1, 1960–May 31, 1961. T. Duane Price (Columbia Univ., New York. Coll. of Physicians and Surgeons). Feb. 28, 1961. Contract AT(30-1)-2208. 36p.

Progress is reported on tracer studies of mechanisms involved in protein synthesis. Data are included from a study of the kinetics of hydrolysis of desoxyribonucleic acids by viper venom phosphodiesterase. P^{32} was used as a tracer in studies of protein synthesis in rat liver. Preliminary results indicate that the condensing units for the minor nucleotide moieties of desoxyribonucleic acid are small-molecule 5′-nucleotides. Thymic ribotide was found to be a natural component of soluble desoxyribonucleic acid, suggesting that it always exists adjacent to another thymic ribotide or a pseudouridylic acid unit. Metabolic origins of minor nucleotide components of soluble desoxyribonucleic acid were studied and an attempt was made to delineate the roles of precursor-products among the different ribonucleic acids investigated. Means to effectively regulate nucleic

acid biosynthesis are reported under investigation. Methods used in the investigations are described. (C.H.)

12697 (WT-1511) BIOMEDICAL AND AEROSOL STUDIES ASSOCIATED WITH A FIELD RELEASE OF PLUTONIUM. Robert H. Wilson, Robert G. Thomas, and J. Newell Stannard (Rochester, N. Y. Univ. Atomic Energy Project). Nov. 1960. Operation PLUMBBOB. 67p.

On Apr. 24, 1957, a high-explosive detonation was employed at the Nevada Test Site to release plutonium for field study of this fissile material as a contaminant. One of four major measurement programs was a biomedical experiment which comprised exposure of animals to first deposition of plutonium oxide from the detonation cloud (acute subjects) and to the wind-induced resuspension of contamination (chronic subjects) as long as six months after original deposition. Acute subjects (26 dogs and 40 rats) were arrayed 500, 1000, and 2000 ft downwind from ground zero, and nine rats were flown on balloon cables positioned to intercept the cloud 500 ft from ground zero. Chronic subjects (three groups of 24 dogs and 3 burros) were placed, after a rough ground-activity survey, at climatologically probable downwind segments of isopleths marking nominal contaminations of 1000, 100, and 10 μg of plutonium per square meter. Serial sacrifices of dogs were made at 4, 5, 16, 32, 64, 128, and 161 days after detonation. Ten tissues per animal were assayed by radiochemistry and autoradiography for plutonium content. All burros received the full 161-day exposure. Ten sheep were distributed among the three field positions on the 32nd day, at which time four additional dogs were placed at the middle position (100-line). All late animals stayed until the end of the maximum exposure period. Air samplers at each chronic field position documented daily mean air concentrations. The pattern of plutonium uptake was surprising in that statistically important numbers of acute and chronic animals showed significant bone burdens in an exposure situation for which lung alone was to have been the critical organ. This outcome was most unusual for acute animals sacrificed less than 4 hr postdetonation. In general, however, all uptakes were less than the forecast amounts. The factor of 100 difference between ground-level contamination at near and far chronic stations brought uptake differences of less than a factor of 10 to indicate that air-borne material accumulates along the upwind path. Air concentrations bear small if any relation to the at foot contamination for natural resuspension forces (wind). An explanation is advanced for the fact that, in an experiment designed to find time dependence in plutonium uptake, no tissues measured exhibited a correlation with exposure time, save GI tract and contents. The plutonium found in bone suggests some deviation from the pure oxide form (extremely insoluble in body fluids) and the presence of solubilizing influences either in early particulate formation or in animal lung. As yet no believable mechanism has been proposed. All autoradiography gave negative results. (auth)

12698 DISTRIBUTION OF RADIOACTIVE IRON IN PREGNANT MICE STUDIED BY WHOLE BODY AUTORADIOGRAPHY. Sven Ullberg, Bo Sörbo, and Carl-Johan Clemedson (Research Inst. of National Defence, Sundbyberg, Sweden; Royal Veterinary Coll., Stockholm; Nobel Medical Inst., Stockholm; and Univ. of Goteborg). Acta Radiol., 55: 145-55(Feb. 1961).

Iron-59 was administered intravenously, and in a few experiments perorally and subcutaneously, to groups of pregnant mice, and the distribution studied in sections of the whole animals by an autoradiographic technique. The uptake of the iron in the organs of the mother and fetus at various intervals is described and discussed. (auth)

12699 CHLOROPLAST PIGMENTS AND PHOTOSYNTHESIS IN DEUTERATED GREEN ALGAE. H. H. Strain, M. R. Thomas, H. L. Crespi, M. I. Blake, and J. J. Katz (Argonne National Lab., Ill.). Ann. N. Y. Acad. Sci., 84: 617-33(Nov. 25, 1960).

Fully deuterated chlorophylls were isolated from the chloroplasts of fully deuterated green algae grown in high concentrations of heavy water. It is pointed out that the most significant difference between the metabolism of hydrogen and deuterium compounds in organisms is the difference in their reaction rates arising from the kinetic isotope effect. Deuterated algae have a particularly useful role in the study of photosynthesis. Topics discussed include the extraction and properties of fully deuterated chlorophylls, the absorption spectra in the visible region, the infrared spectra of ordinary and deuterated chlorophylls, chromatographic comparisons of ordinary and deuterated chlorophyll, the formation of deuterated chlorophyll, and photosynthesis in deuterated algae. (C.H.)

12700 CYTOCHEMICAL STUDIES ON DEUTERATED GREEN ALGAE. E. Flaumenhaft (Hiram Coll., Ohio), S. M. Conrad, and J. J. Katz. Ann. N. Y. Acad. Sci., 84: 634-48(Nov. 25, 1960).

Distinct differences were demonstrated in the morphology and in the amounts and distribution of nucleic acids, proteins, lipids, and carbohydrates in deuterated green algae as compared to ordinary algae. Cytochemical methods used in the study are described. Possible reasons for the differences found are discussed. (C.H.)

12701 THE PLUTONIUM CONTENT IN THE PROTEIN FRACTION OF RAT TUBULAR BONES. I. A. Tseveleva. Biochemistry (U.S.S.R.) (English Translation), 25: 487-9 (Jan.-Feb. 1961).

A study was made of the nature of the distribution of plutonium in the various fractions of the diaphysis of tubular bone. The major part of the radioelement is fixed in the organic matrix. From the organic substances of bone tissue, four protein compounds have been isolated: collagen, albumoid, mucoid, and residual protein. Collagen makes up 90% of the bone protein. Albumoids, mucoids, and residual protein make up, respectively, 2.0, 1.6, and 6.9% (based on nitrogen). All the bone proteins contain plutonium: with collagen, 65–80%; was bound with albumoid, 15%; with mucoid, 3.4%; and with residual protein, 5%. The metabolically active protein (albumoid) binds 10 times more plutonium per mg of nitrogen than do collagen and residual protein. The relative specific activity of mucoid surpasses by 2.5 times that of collagen, which is probably explained by a share of the SO_4^{--} group of chondroitin sulfuric acid in the fixation of plutonium. (auth)

12702 EFFECT OF RADIOPROTECTIVE SULPHYDRYL COMPOUNDS ON THE OXYGEN TENSION IN THE SPLEEN OF MICE. C. Van der Meer, P. W. Valkenburg, and M. Remmelts (Medical Biological Lab., Rijswijk, Z. H., Netherlands). Nature, 189: 588-9(Feb. 18, 1961).

Results are reported from a study of the effect of a number of radioprotective sulfhydryl compounds on the oxygen tension in the spleen and bone marrow of unanesthetized mice and rats. Data are tabulated. (C.H.)

12703 COLLOIDAL YTTRIUM HYDROXIDE-Y-90 AND YTTRIUM PHOSPHATE-Y-90. PREPARATION AND TISSUE DISTRIBUTION FOLLOWING I. V. ADMINISTRATION. R. J. Speer, J. M. Hill, and A. D. Denton, Jr., (J. K. and Susie L. Wadley Research Inst., Dallas and Baylor Univ. Graduate Research Inst., Dallas). Proc. Soc. Exptl. Biol. Med., 106: 444-8(Feb. 1961).

Simple techniques are described for the preparation of 2

new colloids of radioyttrium $Y(OH)_3$ and YPO_4. Maltose was employed as suspending agent for the former, and carboxymethylcellulose for the latter. Both products were demonstrated to have a small, uniform particle size, good emulsion stability, and low percentage dialyzable radioactivity. The LD_{50} of $Y(OH)_3$–Y-90 in mice was approximately 12 to 14 mc/kg. Tissue deposition in mice and terminal human patients was predominantly reticulo-endothelial in both. Evidence is suggestive that some metabolic dissociation occurs with subsequent deposition of yttrium in bone. Urinary excretion of activity was evaluated for mice and man. (auth)

12704 CHANGES OF $Na-Na^{24}$, $K-K^{42}$ AND $P-P^{32}$ EXCHANGE IN MUSCLE BY UTRASONIC IRRADIATION. J. Tigyi. p.716-19 of "Pierwsze Krajowe Sympozjum Poswiecone Stosowaniu Izotopow Promieniotworczych W Biologii, Medycynie, I Rolnictwie, 2 i 3 Kwietnia 1959, Warszawa." Warsaw, Bureau of the Atomic Energy Ministry, 1959. (In German)

Muscle tissue was immersed in Ringer solution into which was added Na^{24}, K^{42}, and p^{32}. In each series of tests, the solution was temperature-regulated. At a point near the muscle specimens, the solution was excited with a piezoelectric apparatus with a frequency of 10^6 cycles and power of 100 watts. Each muscle specimen was then removed, washed, weighed, its threshold of stimulation measured, and the activity of the tracer-isotope was determined as a measure of the exchange of normal and radioactive isotope. The total quantity of sodium, potassium or phosphorus in the tissue was also determined. Each experiment was done in parallel with a control. (TTT)

Fallout and Ecology

12705 (TID-5967) RADIOBIOLOGICAL STUDIES AT THE ENIWETOK TEST SITE AND ADJACENT AREAS OF THE WESTERN PACIFIC. Lauren R. Donaldson (Washington. Univ., Seattle. Lab. of Radiation Biology). Apr. 15, 1959. 19p.

Studies with the radioactive materials resulting from the weapons tests and deposited in the sea and on the islands at Bikini and Eniwetok Atolls in the Marshall Islands have made it possible to follow the biological cycling of these materials even where they have become diluted to infinitesimal quantities. Extensive investigations have answered many questions relating to the economy of the sea, have opened up new knowledge of the life zones of coral atolls, and have reshaped in important ways some of the basic concepts of biological science. The physical and geographic characteristics of the region are described, and the ecology is discussed. A perfect economy of use of substances essential to life has been demonstrated in this region. Little or no time is lost between steps in the biological cycling of materials, for there is not only an abundance of organisms but also a wide variety of species. Available substances are rapidly taken up by the biota. Plankton and some of the algae, which are the key organisms in the food chain, may concentrate within themselves more than a thousand times the amount of radioactive substances found in the sea water. The passage of fission products through the plants and animals of the region is traced. By following the pattern of gross radioactivity, it has been possible to delineate the broad trends in the distribution of radioactive material in an atoll and its surrounding area. Experience in the Pacific has permitted biologists to develop new techniques of investigation and has suggested other areas in which the techniques may be tested and applied. (C.H.)

12706 (UCLA-468) A COMPARISON OF UPTAKE OF $STRONTIUM^{90}$ AND $CESIUM^{137}$ BY BRYOPHYTES AND VASCULAR PLANTS. H. Nishita, D. Dixon, and K. H. Larson (California. Univ., Los Angeles. School of Medicine). Dec. 19, 1960. Contract AT(04-1)-GEN-12. 7p.

An experiment was conducted to compare the uptake of Sr^{90} and Cs^{137} by bryophytes and higher sporophytic plants grown on contaminated soil. (auth)

12707 DISPERSION OF RADIOACTIVE ISOTOPES IN THE SOIL BY EARTHWORMS. A. A. Peredel'skiĭ, S. S. Shain, N. S. Karavyanskiĭ, and G. V. Nikolaev (Inst. of Biological Physics, Academy of Sciences, USSR and Williams All-Union Inst. of (Fodder) Agriculture, [USSR]). Doklady Akad. Nauk S.S.S.R., 135: 185-8(Nov. 1, 1960). (In Russian)

The effects of earthworms on the distribution and migration of radioisotopes in contaminated earth were investigated. Data on the mean Ca^{45} and Sr^{90} activity of a single worm and its coprolith in contaminated soil are tabulated. It is shown that the specific radioactivity in the earthworm quickly reaches a maximum and remains unchanged during further inhabitance in the contaminated soil. The specific activity of the earthworm can reach that of the soil; however, after leaving the contaminated area, the activity is rapidly reduced in the worm. The specific activity of the earthworm coprolith is close to that of the body; sometimes it exceeds the activity of both the body and the soil due to uptake of organic material of higher radioactivity. The experiment shows that the influence of earthworms on dissemination of short-life isotopes is negligible but that with long-life isotopes it may be more noticeable. (R.V.J.)

12708 SOLUBILITY OF RADIOACTIVE BOMB DEBRIS. Don C. Lindsten (Army Engineer Research and Development Labs., Fort Belvoir, Va.), Paul B. Pruett, Richard P. Schmitt, and William J. Lacy. J. Am. Water Works Assoc., 53: 256-62(Mar. 1961).

The radioactive debris resulting from a nuclear detonation was only sparingly soluble in water. The water-soluble component dissolved quickly, with only limited additional solution taking place as a result of further agitation and contact time. Increasing the dosage of contaminated soil resulted in a higher concentration of activity in solution. Leaching the same sample a second time resulted in a solution containing less than one-half the activity in the first leach. The solubility of the radioactive debris increased as the pH of the solvent was lowered. It is therefore concluded that radioactive debris resulting from a normal nuclear detonation is only sparingly soluble in water in the normal pH range of natural surface waters. Where effective clarification procedures are used, only the dissolved radioactive contaminants will be of importance to persons charged with the responsibility for the safety of potable-water systems. To accomplish complete decontamination, normal water-treating (clarification) processes must be supplemented by ion exchange, distillation, or another process that removes all dissolved solids from water. (auth)

12709 STRONTIUM-90 ABSORPTION BY MARINE ORGANISMS. G. G. Polikarpov. Priroda, 50: No. 2, 83(Feb. 1961). (In Russian)

Investigations of green, brown, and red algae Actinia equina, Mytilus galloprovincialis, Leander squilla, and Pachygrapsus marmoratus showed the coefficient of Sr^{90} accumulation in actinia to be 1; in mytilus, 6; in leander, 8; and in crabs, 3. The accumulation coefficient of Sr^{90} in brown algae is 40 to 60, and in green algae it is 1. Sea water removes strontium from dead brown algae until it

reaches the coefficient of a unit; the rest is deposited in the bones and shells. (R.V.J.)

12710 DISTRIBUTION OF STRONTIUM-90 IN A 1959 WHEAT SAMPLE. Joseph Rivera (Health and Safety Lab., New York, AEC). Science, 133: 755-6(Mar. 17, 1961).

At least 22% of the Sr^{90} found in a sample of wheat harvested in 1959 was due to direct deposition. Of the total Sr^{90} content of this wheat sample, 27% was contained in the outermost bran layer. (auth)

12711 Sr^{90} CONTENT OF BONES OF ANIMALS AND HUMANS AND OF MILK IN POLAND IN 1958. Julian Liniecki, Wanda Czosnowska, and Zofia Pietrzak. p.699-703 of "Pierwsze Krajowe Sympozjum Poswiecone Stosowaniu Izotopow Promieniotworczych W Biologii, Medycynie, I Rolnictwie, 2 i 3 Kwietnia 1959, Warszawa." Warsaw, Bureau of the Atomic Energy Ministry, 1959. (In Polish)

The Sr^{90} content was measured in bones of humans, in the bones of animals from 6 slaughterhouses, and in milk from 3 widely separated processing plants. The bone activity is given as a function of age of animals and humans at death and as a function of the month of the year of slaughter for animals and the month of the year of production for milk. For beef cattle, the Sr^{90} activity is large for young animals and has a tendency to reach an equilibrium value with increase of age. The mean human Sr^{90} activity decreases with age-at-death, and the mean activity for the group above 20 years of age (14 cases) is about 12 times that measured in the U. S. two years earlier. For all animals it is about 3 times higher. The method of measurement was based on the separation of Y^{90} in equilibrium with Sr^{90}. The resultant Sr^{90} activity is then measured. This method was similar to that reported by H. L. Volchok, et al, (Ann. N. Y. Acad. Sciences, 71: 293, (1957)) with the following improvements, checks, and precautions: The method of separating calcium oxalate was changed and ammonium oxalate was replaced in the series with oxalic acid; $Y(OH)_3$ was found to begin separating out at a pH of about 7.5 instead of the reported value of 5. Therefore a value of 8 was used in the separations; and large losses of yttrium oxalate were found to occur if the temperature of the solution was allowed to rise above 60°C. Lack of temperature control could result in a loss of 15 to 20% in Y^{90}. (TTT)

12712 MEASUREMENTS OF TOTAL BETA ACTIVITY OF VEGETATION IN POLAND. R. Szepke, D. Klarzynska, M. Wilk, and H. Bartkiewicz. p.714-16 of "Pierwsze Krajowe Sympozjum Poswiecone Stosowaniu Izotopow Promieniotworczych W Biologii, Medycynie, I Rolnictwie, 2 i 3 Kwietnia 1959, Warszawa." Warsaw, Bureau of the Atomic Energy Ministry, 1959. (In Polish)

Desiring to determine the degree of contamination of Poland from nuclear explosions, reactors, and isotope labs, the Central Laboratory of Radiological Protection in Warsaw is launching a program to monitor radiation in such environments as soil, plant life, water reservoirs, and in various food products. About 300 measurements of total β activity in vegetation in $\mu c/g$ ash were made in 1958 in the period June through December. A thin-window GM counter was used and the statistical certainty was held to 95%. Measurements were made at various altitudes and the β decay curves were measured over a period of 100 days for samples of vegetation taken from 4 mean altitudes; 6700, 1965, 1040, and 550 meters. The half life increased with decreasing altitude and covered a range of 30 to 50 days. The high altitude measurements showed an activity several times larger than for vegetation at low altitudes. Measurements of β activity in the vegetation in the vicinity of Warsaw were made in the months June through October. This activity followed the time variations of fall-out activity measured in the same vicinity except for the months of fastest growth when temporary mineral depletion in the soil may have decreased the uptake of β-active chemicals of the growing vegetation. The activities are in general agreement with those reported in other countries. (TTT)

Radiation Effects on Living Tissues

12713 (BNL-609) MEDICAL SURVEY OF RONGELAP PEOPLE FIVE AND SIX YEARS AFTER EXPOSURE TO FALLOUT (WITH AN ADDENDUM ON VEGETATION). Robert A. Conard, H. Eugene Macdonald, et al. (Brookhaven National Lab., Upton, N. Y.). Sept. 1960. 86p.

Annual medical surveys of the people of Rongelap Island were carried out in March 1959 and March 1960, 5 and 6 years after their accidental exposure to fall-out. During the 1959 survey 76 exposed adults (and their children) and 166 unexposed persons, who served as a comparison population, were examined. In addition, groups of children at nearby atolls were examined as controls for the growth and development studies on the exposed Rongelap children. In 1960 only the exposed people were examined. As a result of their exposure in 1954, many of the Rongelap people experienced early symptoms related to the gastrointestinal tract and skin. Later they developed a significant depression of their peripheral blood elements commensurate with the 175 and 69 r calculated dose of γ radiation. Beta burns of the skin and spotty epilation also were found. Radiochemical analysis of urine samples showed that they had acquired a low-level body burden of radionuclides. Certain other findings possibly related to radiation exposure included loss of weight in adults and a slight lag in growth and development of the children. No deaths occurred that could be related to their radiation exposure, and no specific therapy was given. The 5- and 6-year postexposure surveys were aimed primarily at evaluating the general medical status of the people in relation to that of the unexposed comparison population. Results are summarized from surveys on mortality rate; birth rate; physical examinations; growth and development studies; cardiovascular, ophthalmological, dental, and hematological surveys; measurements of the various parameters usually associated with aging; and possible genetic effects. Body burdens of γ-emitting fission products, such as Cs^{137} and Zn^{65}, were measured in a whole-body counter and checked by radiochemical analysis of urine specimens. Body burdens of Sr^{90} were estimated from urinary excretion as determined by radiochemical analyses. This study of the internal contamination of the Marshallese provided information on the movement of Cs^{137}, Zn^{65}, and Sr^{90} from the environment to man, on the rate of equilibration of these isotopes with the environment, and on the discrimination factors between food and man. Data are included on changes in the vegetation of Rongelap Atoll which may be due to radioactive fallout. Tabulated data are appended. 57 references. (C.H.)

12714 (TID-11524) THE EFFECT OF X-RAY IRRADIATION ON THE DESOXYRIBONUCLEIC ACIDS OF THE SPLEEN AND RADIOSENSITIVE TISSUE. Progress Report for the Period May 1, 1960 through January 31, 1961 and Proposal for Renewal of the Contract from May 1, 1961 through April 30, 1962. Henry P. Schwarz (Philadelphia General Hospital). 28p. Contract AT(30-1)-2568.

The chromatographic pattern of desoxyribonucleic acids of the spleen from irradiated and nonirradiated rats was found to be qualitatively similar but to differ quantitatively. Preliminary observations showed that when chromatograms of the desoxyribonucleic acid from irradiated and

nonirradiated spleens were compared it could be demonstrated that the desoxyribonucleic acid from the irradiated tissue was eluted earlier at the expense of the less easily eluted fractions. Analyses of the chromatographic fractions by infrared spectroscopy, light scattering, and other methods are in progress. (C.H.)

12715 (TID-11562) THE EFFECT OF X-RADIATION ON LONGEVITY IN DROSOPHILA MELANOGASTER. Technical Progress Report. (Taylor Univ., Upland, Ind.). [1961]. Contract AT(11-1)885. 11p.

Progress is reported in studies on the effects of x irradiation on the life span of Drosophila. (C.H.)

12716 (TID-11736) PROGRESS REPORT [ON EFFECTS OF RADIATION ON PLANT METABOLISM], MAY 15, 1960 TO FEBRUARY 1961. Smithsonian Institution, Washington, D. C.). Contract AT(30-1)-2373. 61p.

Progress is reported in studies on the effects of ionizing and nonionizing radiations on plants. Data are presented on reaction mechanisms involved in chlorophyll synthesis; physiological phenomena involved in red and far-red reactions; the rate of chlorophyll synthesis of dark-grown leaves at various stages of development; the interaction between x-ray-induced chromosome aberrations and the effects of far-red radiant energy in chromosomes; photomimetic responses in plants; protein synthesis associated with the formation of the complete photosynthetic system in plants; and the kinetics of leaf-disk expansion in photomorphogenic response. (C.H.)

12717 (TID-11809) THE ACTION OF RADIATION AND OTHER MUTAGENIC AGENTS (1) IN INDUCING MUTATION IN DROSOPHILA FEMALES, AND (2) IN CONTROLLING THE ACTION OF SPECIFIC GENES RESPONSIBLE FOR SUPPRESSING UNCONTROLLED GROWTH. H. Bentley Glass (Johns Hopkins Univ., Baltimore). Feb. 15, 1961. 7p. Contract AT(30-1)-1472.

Results are summarized from a study on the effect of a 5-r dose of x radiation on the induction of mutations in Drosophila melanogaster. Results are also summarized from tracer studies on metabolic pathways involved in the formation of brown-spot eye pigment and the supression of tumor genes in Drosophila melanogaster. (C.H.)

12718 (TID-11913) RADIATION EFFECTS OF PLANTS. Progress Report, April 1, 1960-January 15, 1961. Richard W. Van Norman and John D. Spikes (Utah. Univ., Salt Lake City). Jan. 15, 1961. Contract AT(11-1)-875. 11p.

Results are reported from a study on the effects of chronic γ irradiation on the growth and yield of sugar beets. Sugar content increased slightly as dose rate increased. Mixtures of chlorophylls were found to be affected somewhat differently by exposure to x radiation as compared to the individual pigments alone. Progress is reported in studies on energy absorption and transfer in photosynthetic reactions and in studies on the inactivation of dye-sensitized crystalline trypsin by visible light. (C.H.)

12719 (TID-11914) PROGRESS REPORT [ON RADIOSENSITIVITY OF BARLEY SEEDS], 1960-61. (Minnesota. Univ., Minneapolis). 6p.

Progress is reported in an investigation of environmental parameters affecting the radiosensitivity of barley seeds. Data are included from studies on the relation of genetic injury to oxygen availability, the temperature dependence of postirradiation storage injury, and the relation of genetic injury to seedling height in postirradiated stored populations. The relation between chromosomal structural changes and events considered as point mutations was studied in barley. Data are also included from a study of the effects of recurrent irradiation on the seed of diploid, tetraploid, and hexaploid oats and diploid barley. (C.H.)

12720 (TID-11936) EFFECTS OF IRRADIATION ON PLANT TISSUES. Progress Report. James E. Gunckel (Rutgers Univ., New Brunswick, N. J.). Mar. 1, 1961. Contract AT(30-1)-1120. 6p.

Progress is reported in an investigation of tumor formation induced by irradiation in a tobacco hybrid, Nicotiana glauca XN. langsdorffii. The incorporation of methionine, labeled with S^{35} in chlorophylls and proteins of chloroplasts was measured. The effects of x rays on protein synthesis and photosynthetic phosphorylation was also studied in pea root tips, using methionine labeled with S^{35} as a tracer. Results indicate that x radiation probably has an indirect effect on protein synthesis through alteration of the electron-transfer system during the synthesis of adenosine triphosphate. (C.H.)

12721 (TID-12122) EFFECT OF IRRADIATION ON THE LOCALIZING RESPONSE (TO ANTIGEN) OF DIFFERENT TISSUES IN IMMUNITY. Progress Report and Proposal for Continued Studies. Reuben L. Kahn (Michigan. Univ., Ann Arbor). Jan. 12, 1961. Contract AT(11-1)-70. 15p.

Results are summarized from a series of studies on the inflammatory reaction resulting from radiation injuries in rabbits. The capacity of irradiated skin areas to retain or localize bacteria and foreign protein was measured. Results indicate a deficiency in the localizing response of the inflammatory reaction associated with radiation injuries of the skin. (C.H.)

12722 (TID-12124) THE OCCURRENCE OF CHROMOSOMAL ABERRATIONS IN PRESPERMATOCYTIC CELLS OF IRRADIATED MALE MICE. Progress Report, November 1, 1959 – December 31, 1960 and Extension Period January 1, 1961 – February 28, 1961. Third Renewal Proposal, March 1, 1961 – February 28, 1962. Allen B. Griffen (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Mar. 1, 1961. Contract AT(30-1)-2113. 9p.

Progress is reported on studies designed to determine the nature and extent of radiation damage to the chromosome system of prespermatocytic cells. Male mice were subjected to x-ray treatment of the testes at three different radiation dosages. The treated individuals were mated to untreated females. All offspring were tested for the presence of chromosomal aberrations capable of producing semisterility. An initial period of good fertility was observed for approximately one month after irradiation. This period was followed by a period of sterility which varied in duration with the x-ray dose. During the sterile period, spermatogenesis ceased, and spermatogonia were scarce or absent. Preliminary data are presented on chromosome aberrations in the offspring of irradiated males. (C.H.)

12723 (TID-12167) A STUDY OF THE EFFECTS OF RADIATION ON BIOLUMINESCENT MATERIALS. Howard H. Seliger (Johns Hopkins Univ., Baltimore. McCollum-Pratt Inst.). [1961]. 10p.

Progress is reported in studies on the quantum yields of bioluminescence and chemiluminescence and the role of oxygen in biological oxidations. Emphasis was placed on studies of mechanisms involved in firefly and bacterial bioluminescence. A list of publications during the period is included. (C.H.)

12724 (USNRDL-TR-456) COMPARATIVE MORTALITY FOLLOWING PARTIAL AND WHOLE BODY IRRADIATION OF RATS WITH FAST NEUTRONS AND X-RAYS. M. N. Swift and S. T. Taketa (Naval Radiological Defense Lab., San Francisco). Aug. 18, 1960. 25p.

Using acute mortality as the endpoint, the relative biological effectiveness (RBE) of simulated fission neutrons with respect to 250 kvp unfiltered x rays was determined

in the rat for exposure of whole-body, abdomen-hindquarters only, and head-thorax only. For whole-body exposure, an RBE of 2.8 was obtained for both 5- and 30-day endpoints, the former representing acute intestinal deaths only and the latter including both bone marrow and intestinal deaths. Although these RBE's were identical, neutron-irradiated rats appear to show a somewhat greater radiosensitivity of intestine relative to bone marrow than do x-irradiated rats. Thus, at any given 30-day lethal level, the proportion of rats dying early (by 5 days) is slightly greater in the case of neutron-exposed animals. Following exposure of abdomen-hindquarters only, essentially no mortality occurred after 5 days. The RBE for intestinal deaths in these rats was also 2.8. The RBE of neutrons for head-thorax exposure, producing oropharyngeal 9 to 16-day deaths, was found to be 3.0. (auth)

12725 (USNRDL-TR-468) THE TOLERANCE OF ANIMALS TO ACUTE COLD EXPOSURE FOLLOWING X-IRRADIATION. B. D. Newsom and D. J. Kimeldorf (Naval Radiological Defense Lab., San Francisco). Oct. 11, 1960. 22p.

A study was made to determine if x irradiation alters the tolerance of rats and guinea pigs to acute exposures of severe cold (−20°C) at various times after irradiation. It was found that the tolerance is lowered following irradiation. The cold tolerance of rats varied inversely with radiation dose and the effect was present on the first day after sublethal doses of x rays. Following sublethal irradiation (400 r), the altered tolerance persisted through the eighteenth day and then disappeared. Following LD_{50} exposures to x rays, the surviving rats exhibited a lowered cold tolerance at 6 months after irradiation. The role of body weight loss and possible mechanisms for the lowered cold tolerance following irradiation are discussed. (auth)

12726 (WT-1470) MISSILE STUDIES WITH A BIOLOGICAL TARGET. V. C. Goldizen, D. R. Richmond, T. L. Chiffelle, I. G. Bowen, and C. S. White (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Apr. 1960. 64p.

Fourteen dogs located on the lee side of planted gravel, of a concrete-block wall, and of glass mounted in the open and in houses were exposed to the environmental variations associated with full-scale nuclear detonations. Aluminum foil was used to protect the animals from thermal effects. The missile environment was monitored through the use of quantitative missile-trapping techniques. Pressure-time variations in the environment were also recorded. Biologic damage from overpressure and missiles was determined, and the associations between physical environmental factors and biologic response were noted and analyzed. The feasibility of utilizing missile data, along with other available information from the literature, as a means of quantitatively assessing biologic hazard was established by the close correspondence between observed and predicted dangerous wounds. This test provided full-scale validation of procedures and experiments worked out chiefly in the laboratory. (auth)

12727 (CEA-tr-R-1036) EFFETS RETARDES DES RADIATIONS IONISANTES SUR LA VITAMINE C ET LA CAROTENE CONTENUES DANS CERTAINES PREPARATIONS ET PRODUITS ALIMENTAIRES. (Delayed Effects of Ionizing Radiations on Vitamin C and Carotene Content in Certain Food Products and Preparations). G. M. Eguiazarov. Translated into French from Voprosy Pitaniya, 17: No. 5, 9-11(1958). 7p.

The delayed effects of Co^{60} γ radiation on vitamin C and carotene were studied in samples of sauerkraut, tomato puree, pellets of vitamin C, and carotene in oil. The vitamin C and carotene concentration was determined before and after γ irradiation. The samples were kept in darkness at 12°C. The results of the tests are tabulated. The organoleptic characteristics of all the samples were unchanged. No delayed effects were observed in the vitamin C and carotene in the food products studied, however, a delayed effect was noticed in the carotene in oil. (J.S.R.)

12728 (JPRS-4387) RADIATION INJURY AND AUTOLYSIS. V. N. Benevolenskii (Benevolenskiy). Translated from Uspekhi Sovremennoi Biol., 50: 310-21(1960). 33p.

Autolysis is generally understood to mean the posthumous disintegration of tissues due to their self-digestion. An analogous effect is observed in the life of a multicellular organism in the form of cell cytolysis and aseptic necrosis of tissue. The disintegration of tissue proteins is brought about not only by the ferments of disintegrating cells but also by the ferments produced by the surrounding healthy tissues and white blood cells. The mechanisms of their action are similar to the action of autolytic ferments. The destructive effects in living tissues lead to functional disturbances in the living organism or to the loss of life. The concept of an autolysis-like process in irradiated organisms is discussed. Results are reported from the analysis of tissues irradiated in vitro and in vivo. Characteristics of changes observed in radiation sickness and autolysis are compared. Reaction mechanisms involved in radiation injury are discussed. 95 references. (C.H.)

12729 X-RAY-INDUCED CHROMOSOME ABERRATIONS AND REPRODUCTIVE DEATH IN MAMMALIAN CELLS. M. A. Bender and Sheldon Wolff (Oak Ridge National Lab., Tenn.). Am. Naturalist, 90: 39-52(Jan.-Feb. 1961).

The kinetics of x-ray-induced chromosome aberrations in mammalian cells were found to be similar to that in plants. In particular, the shapes of dose curves for one- and two-break aberrations are similar in both types of material, as are the distributions per cell of the various types of aberration. It may be concluded that there is no threshold dose for aberrations and random samples of damage are obtained from cells sampled at the first postirradiation metaphase. The dose required to produce one break per cell in irradiated human diploid epithelioid cells in vitro was calculated to be about 190 r. This dose is similar to the dose required to produce one break per cell in mammalian cells in vivo, but much higher than the value for fibroblasts in vitro. Studies of the x-ray survival kinetics of a hypotetraploid human cell line similar to that used in other studies have shown that the survival of these cells better fits a compound curve containing both single- and multiple-hit components than a simple sigmoidal curve. Data on the numbers of cells not having x-ray-induced 2-hit chromosome aberrations show that these cells do not fit the quantitative pattern required by the hypothesis that x-ray-induced cell killing is caused mainly by the production of visible 2-hit chromosome aberrations. Although it is reasonable to assume that these aberrations cause a proportion of such killing, their relation to killing is obscure, and certainly other targets, both cytoplasmic and nuclear, should be taken into consideration. 31 references. (auth)

12730 DIFFERENTIAL EFFECT OF X-RAYS ON DROSOPHILA EGGS DERIVED FROM RECIPROCAL CROSSES IN DROSOPHILA MELANOGASTER. A. A. Buzzati-Traverso (Università, Pavia, Italy). Atti assoc. genet. ital., 5: 113-15(1960). (In Italian) (CNEN-12)

Some evidence in the literature on the process of hetero-

chromatization in salivary chromosomes, as well the expression of the white locus in compound-X D. melanogaster, indicates that these two phenomena are different when a certain chromosome is paternal, as compared to maternal, in origin. This represents an unexpected exception to the general rule according to which the behavior of identical genotypes is identical, short of maternal effects, in a diploid zygote, irrespective of whether they are carried via the sperm or the egg. In order to ascertain whether mutation rates of the same genes are different when derived from the male, as contrasted to the female, batches of 1-hr-old eggs of D. melanogaster obtained from the cross ♂ y w^a cv v f × ♀ + and its reciprocal y w^a cv v f ♂ + × ♀ were x rayed with doses of 340 and 680 r. While no significant differences were found in the frequencies of somatic mutants, as revealed by mosaics, unexpected differences were found in the egg mortality and in the sex ratio of the surviving adults. The data are tabulated. (auth)

12731 RATE OF MICROEVOLUTIONARY PROCESSES IN IRRADIATED POPULATIONS. A. A. Buzzati-Traverso (Università, Pavia, Italy). Atti assoc. genet. ital., 5: 183-4(1940). (In Italian) (CNEN-7)

In previous experiments it was shown that the rate of microevolutionary processes leading to higher fitness is higher in D. melanogaster populations treated with x rays than in nonirradiated control populations. Physiological traits, such as fecundity, as well as morphological traits controlled by polygenic systems were shown to undergo evolutionary change. In the course of a set of experiments currently under way, many populations are under study in which the mutant spineless (ss) of the III chromosome is used as a marker in combination with other recessive mutants. In a relatively large number of such populations individuals have appeared whose bristles were appreciably longer than those in the ss mutant. Since their first appearance, the percentage of such nonspineless individuals steadily increased, thus showing that they posses positive selective value. This trait was shown to be due to different sets of polygenes in each population. A comparison between irradiated and nonirradiated populations shows that the rate of occurrence of such polygenic mutants affecting the ss phenotype is markedly different in different populations. Indistinguishable phenotypic changes can thus show different selective values, depending on the polygenic system by which they are controlled. (auth)

12732 ELECTRON SPIN RESONANCES IN BACTERIOPHAGE: ALIVE, DEAD, AND IRRADIATED. A. Muller, G. Hotz, and K. G. Zimmer (Nuclear Research Center, Karlsruhe, Ger.). Biochem. Biophys. Research Communs., 4: 214-17(Mar. 10, 1961).

The electron-spin-resonance spectra of Escherichia coli bacteriophage were taken under various conditions and after various treatments, including irradiation. Data are presented graphically and discussed. (C.H.)

12733 DEOXYRIBONUCLEIC ACID INSTABILITY IN THE PRESENCE OF CHLORAMPHENICOL IN ULTRAVIOLET-LIGHT-EXPOSED BACTERIA. C. O. Doudney (Univ. of Texas, Houston). Biochem. Biophys. Research Communs., 4: 218-22(Mar. 10, 1961).

The relation of ribonucleic acid to desoxyribonucleic acid synthesis was studied in cultures of Escherichia coli. Data are presented on the effects of chloramphenicol added immediately following ultraviolet irradiation on the synthesis of desoxyribonucleic acid. Possible reaction mechanisms involved are discussed. (C.H.)

12734 THE ELECTROCHEMICAL PROPERTIES OF IMMUNE PROTEINS SYNTHESIZED IN AN IRRADIATED ORGANISM. L. G. Prokopenko (State Medical Inst., Kursk, USSR). Biochemistry (U.S.S.R.) (English Translation), 25: 482-6(Jan.-Feb. 1961).

Agglutinins against Bact. paratyphi B. and precipitins against the proteins of human serum, which are produced in the healthy rabbit after the first injection of antigen, migrate in the electric field along with the γ globulins. A third injection causes the appearance in the blood of the animals of an antibody with electrophoretic mobility of β globulins. In the organism of rabbits irradiated with doses of 600 r, synthesis of antiparatyphoid agglutinins with the electrophoretic mobility of γ and β globulins was found. After the first injection of antigen in animals irradiated with a dose of 1000 r, agglutinins appeared in their blood which were localized in the γ-, β_1-, and α_2-globulin fractions. The third injection of antigens caused formation of antibodies with the mobility of γ globulins. Precipitins in the injured rabbits were localized only in the γ-globulin fraction. (auth)

12735 RADIATION INACTIVATION OF CELL NUCLEI AS THE METHOD OF STUDY OF THEIR ROLE IN THE DEVELOPMENT OF RESPIRATION IN FISH EMBRYOS. A. A. Neifakh (Severtsov Inst. of Animal Morphology, Academy of Sciences, Moscow). Biochemistry (U.S.S.R.) (English Translation), 25: 503-11(Jan.-Feb. 1961).

The rate of respiration in the embryos of the groundling remains constant up to the 5th to 7th hour of development, i.e., to the middle blastula stage. The rate of respiration then suddenly increases and over the course of embryonic development reaches 7 to 8 times its original level. Ionizing radiation (40,000 r) does not decrease the rate of respiration, but quickly stops the increase in the rate, acting, therefore, not on the respiratory apparatus of the cell, but on the process of its development. The unimpaired development of the respiratory apparatus in embryos with irradiated cytoplasm but intact nuclei and the cessation of development after irradiation of the nucleus show that suppression of the development of the respiratory apparatus by irradiation is brought about by the destruction of the nuclear apparatus that controls the increase in the rate of respiration during the course of development. In irradiated embryos the rate of respiration becomes constant within a short time and remains at this level right up to the time when the embryo dies. A comparison of the stage of development to which the rate of respiration in irradiated embryos corresponds with the stage of development at the time of irradiation shows that the cytoplasm possesses the capacity to increase the rate of respiration for some time without nuclear control. An analysis of the dependence of the capacity of the respiratory apparatus to develop without nuclear control on the stage of development makes it possible to establish periods in which the nucleus exerts its control over the development of respiration. These periods closely parallel those of nuclear control over morphological development. The chain of intermediate processes occurring between the nucleus and the development of the respiratory apparatus appears to be significantly shorter than that between the nucleus and the development of morphological features. The development of the respiratory apparatus is considered as a model of cell differentiation in development. The possibilities of investigating the mechanisms of development by means of radiation inactivation of nuclei in this model are discussed. (auth)

12736 NUCLEIC ACID CONTENT OF CELLULAR COMPONENTS OF THE MUCOSA OF THE SMALL INTESTINE AFTER γ-IRRADIATION. N. V. Ermolaeva.

Biochemistry (U.S.S.R.) (English Translation), 25: 517-19(Jan.-Feb. 1961).

Following the action of general irradiation with Co^{60} γ rays in 1000-r doses, during the first day (2, 6, and 24 hr) after irradiation, changes of a cyclic nature were observed in the content of nuclear DNA of the mucosa of the rabbit small intestine. Under the same conditions, the content of RNA in the nuclei, mitochondria, microsomes, and hyaloplasm of cells of the rabbit small intestine mucosa remained essentially unchanged. (auth)

12737 THE EFFECTS OF IONIZING RADIATION IN HIBERNATION. Douglas E. Smith (Argonne National Lab., Ill.). Bull. Museum Comp. Zoology, 124: 493-506(1960).

Available data are reviewed on the effects of ionizing radiations on the induction and maintenance of the state of hibernation in mammals. It is concluded that lethality resulting from irradiation is greatly slowed in hibernating mammals. After the period of hibernation is ended, death occurs as in the case of nonhibernating-irradiated animals. Distinct differences were found between the ground squirrel and the dormouse with respect to the possible protection by cysteine given after irradiation. Only those dosages of radiation that are high enough to elicit signs of altered function of the nervous system prevent the bat and the ground squirrel from entering hibernation. (C.H.)

12738 COMBINED ACTION OF CIGARETTE TAR AND BETA RADIATION ON MICE. E. V. Cowdry, A. Croninger, S. Solaric, and V. Suntzeff (Washington Univ. School of Medicine, St. Louis). Cancer, 14: 344-52(Mar.-Apr. 1961).

Periodic beta irradiation from Sr^{90} to distributed areas of the skin of mice in total doses of as much as 20,800 rep when applied concurrently with cigarette tar produces an additive effect in the production of epidermal carcinogenesis. There is no evidence of a synergistic effect between the two carcinogens. Radiation alone has little carcinogenic effect on the skin as applied under the conditions described. Groups with greater percentages of malignant skin tumors have had shorter lives than those with smaller percentages or without skin tumors. The percentage of tumors of the lung, leukemia, mammary-gland carcinoma, and hepatoma was greater in groups in which the percentage of malignant tumors of the skin was low. (auth)

12739 EFFECTS OF GAMMA-RAYS ON GERMINATION AND GROWTH IN SOME SPECIES AND HYBRIDS OF SACCHARUM. U. Vijayalakshmi and J. T. Rao (Sugarcane Breeding Inst., Coimbatore, India). Current Sci. (India), 29: 397-8(Oct. 1960). (In English)

The reaction of the different species of Saccharum and some hybrid sugar cane varieties to irradiation was studied for doses of 500 to 10,000 r. After irradiation the cuttings were planted in pots and weekly observations were recorded on germination, height, leaf area, and mutations, if any. Results indicated that the upper limit of safe dosage for normal germination and growth would be about 3000 r. (M.C.G.)

12740 DAMAGE TO GROWING HUMAN BRAIN AFTER THERAPEUTIC X IRRADIATION. Hanns Solcher (Neurologische Universitätsklinik, Wurzburg, Ger.). Deut. Z. Nervenheilk., 180: 432-49(1960). (In German)

After a literature compilation on x ray of late injuries to the growing human brain, two special cases are described. In the first case, after a small focus dose of 3200 r on a spongio blastoma of the brain stem several necrosis centers appeared in the medullary layer of the hemisphere and the hypothalamus. The second case showed after a surface dose of 8400 r a total medullary necrosis without primary injury to the surrounding cortex. From the distribution pattern of the damage, it is concluded that with x ray of late effects it is not just a case of vessel damage and its effects but a primary injury to the medullary layer is involved. Injuries after smaller radiation doses are notably oedema and inflammation of the brain. (tr-auth)

12741 THE ROLE OF THE NERVOUS SYSTEM IN THE CHANGE OF THE LEVEL OF FREE HISTAMINE IN THE TISSUES ACTED UPON BY IONIZING RADIATION. E. I. Krichevskaya (Inst. of Biological Physics, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 135: 193-6 (Nov. 1, 1960). (In Russian)

The influence of ionizing radiation on free histamine levels in tissues was studied with the exclusion of receptory apparatus to determine if the observed increase of free (biologically active) histamine in various organs results from a direct radiation effect or a reflex reaction. Experiments with anesthetized male white rats weighing 140 to 180 g exposed to 1000 r at a dose rate of 31.4 r/min show that the increase in free histamine levels is a reflex reaction. (R.V.J.)

12742 ON CERTAIN PECULIAR ASPECTS OF THE FUNCTIONS OF THE HIGHER PARTS OF THE CENTRAL NERVOUS SYSTEMS OF ADULT RABBITS SUBJECTED TO IONIZING RADIATION AT THE ANTENATAL STAGE OF DEVELOPMENT. R. I. Kruglikov (Inst. of Higher Nervous Activity, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 135: 225-8(Nov. 1, 1960). (In Russian)

Experiments were carried out with progenies of rabbits exposed to 400 r of x radiation at 16.5 r/min. The higher nervous activity of 4-month-old progenies was studied by observing conditioned and specialized conditioned reflexes. Conditioned reflexes were studied by using 13 experimental rabbits and 15 control rabbits at the same time. Specially conditioned reflexes were elicited in experimental rabbits with great difficulty. Moreover, motor responses were more generalized and exhibited a large number of extra motions in the exposed animals. Retarded responses to signals and more prolonged retention of intersignal reactions result from a prolonged afferent generalization. (R.V.J.)

12743 RECENT DATA ON STREPTOMYCIN, A FACTOR CONTROLLING RADIO-DAMAGE EFFICIENCY IN CELLS OF MAMMALIANS. N. V. Belitsina and N. I. Shapiro (Inst. of Biophysics, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 135: 463-6(Nov. 11, 1960). (In Russian)

The protective effects of streptomycin against radiation-induced chromosome aberrations and the prophylaxis and therapeutic effects of this antibiotic and its effects on cells at various stages were studied in ascitic carcinoma cells irradiated in vitro with 1500 r of γ radiation. The results showed that streptomycin has a partial therapeutic value that is limited to a short interval after exposure and should be applied before the first cell division. (R.V.J.)

12744 CHANGES IN THE MORPHOLOGICAL COMPOSITION OF PERIPHERAL BLOOD IN DOGS OF VARIOUS HIGHER NERVOUS ACTIVITY TYPES UNDER THE INFLUENCE OF CHRONIC EXTERNAL RADIATION WITH SMALL DOSES OF GAMMA RAYS (Co^{60}). A. F. Makarchenko, M. F. Sirotina, and R. S. Zlatin. Fiziol. Zhur. Akad. Nauk Ukrain. R. S. R., 5: 769-74(1959). (In Russian)

Systematic observations of the morphological composition of blood in dogs subjected to total-body external radiation by small doses of γ rays (Co^{60}) daily for 6 hr with a

dose of 0.05 r per day showed that perceptible changes in the hematological indicators are distinguished by great lability. The most pronounced effect was the polycythemic reaction, which was noted in most of the experimental animals during a period of 5 to 9 months after the beginning of radiation. During this period a distinct increase was noted in the number of thrombocytes. The data indicate that animals of the strong type of higher nervous activity yield responses of a different nature during definite periods of the action of penetrating radiation than animals of the weak type. During a year no degenerative manifestation in the morphological components of the peripheral blood was noted in the investigated animals. (auth)

12745 INFLUENCE OF IONIZING RADIATION ON THE NERVOUS SYSTEM OF ANIMALS. R. S. Zlatin. Fiziol. Zhur. S.S.S.R., 5: No. 1, 130-46(1959). (In Ukrainian)

A review is given of published data on the radiosensitivity of the central nervous system in therapeutic treatments and in general exposures to ionizing radiation. 94 references. (R.V.J.)

12746 THE GENETIC SENSITIVITY TO X-RAYS OF MOUSE FOETAL GONADS. T. C. Carter, Mary F. Lyon, and Rita J. S. Phillips (Medical Research Council Radiobiological Research Unit, Harwell, Berks, Eng.). Genet. Research, 1: 351-5(Nov. 1960).

The mutation rate at seven specific loci was measured among the offspring of male and female mice exposed as 17-day-old fetuses to 200-r x rays. In the female series, the mutation rate was lower, by a factor of about 4, than in the comparable adult rate; in the male series, the mutation rate was lower but not statistically significantly lower than in adults. (auth)

12747 EFFECT OF X-IRRADIATION ON ESTROGEN-INDUCED PROTEIN SYNTHESIS IN THE CHICK. Ole A. Schjeide, Sue Simons, and Nancy Ragan (Univ. of California, Los Angeles). Growth, 23: 273-90(Sept. 1959).

Under none of the experimental conditions or in any of the stages studied was whole-body x-irradiation (400 to 750 r) followed by significant changes in serum concentrations of estrogen-induced lighter lipoproteins, X_2-lipoglycoproteins, or X_1-phosphoproteins. Small but statistically significant increases in total serum lipids and dense lipoproteins were observed, as were decreases in serum albumin. No indications of gross changes in turnover of serum proteins (labeled with methionine- or cysteine-S^{35}) were detected following whole-body irradiation of chicks. (auth)

12748 PROTECTION FROM TOTAL-BODY IRRADIATION. John M. Knox, A. Clark Griffin, Raouf E. Hakim, Hugh D. Bennett, Harry L. Barton, Vincent P. Collins, and Robert G. Freeman (Baylor Univ., Houston, Tex.). J. Am. Med. Assoc., 175: 941-5(Mar. 18, 1961).

A series of experiments was performed to determine whether or not agents that alter the effects of ultraviolet light might favorably influence the survival rate after total-body exposure to ionizing irradiation. Antimalarials, psoralen, benzophenones, and a benzotriazole were administered in the diet to albino mice before irradiation. The results were inconclusive but suggested that certain agents of this type may be capable of providing some degree of protection and that further experimentation and evaluation would be justified. The need for research on practical methods for protecting man from the effects of excessive radiation is emphasized. To date the sulfhydryl compounds have shown the most promise for this purpose. (auth)

12749 NEGLIGIBLE EFFECTS OF X-RADIATION OF THE HEAD UPON HEARING IN THE RAT. Jerome E. Murphy and J. Donald Harris (C. W. Shilling Auditory Research Center, Inc., Groton, Conn.). J. Auditory Research, 1: 117-32(1961). (NYO-9013)

Groups of white rats were trained to press a lever for food during the periods when an otherwise constant tone of 4 kc was modulated in a sinusoidal fashion either 4 db in intensity or 4% in frequency. Other rats were trained to respond in a shuttlebox to the onset of modulation. At a stage in his acquisition curve, an individual rat was given a single dose of 200 r directed toward the rear half of the skull. No effect on the learning curves could be observed, whereupon the dose was changed to 500 r. Rats given this larger dose were able to maintain both lever-pressing and shuttle-box habits, though a few days after x radiation at 500 r the shuttlebox habit showed some deterioration for both types of modulation. A dose of 500 r had no effect on the audiogram, as measured by the Preyer pinna reflex, or upon the 1 μv cochleogram, as compared with the average normal untreated rat. If a deterioration occurred in the shuttlebox situation the effect was not primarily on the peripheral sense organ. (auth)

12750 NEUROVEGETATIVE CHANGES IN CHILDREN SUBJECTED TO X-RAY EPILATION. E. G. Dolgov and I. I. Pilger. (Semipalatinsk Inst. of Medicine, USSR). Med. Radiol., 5: No. 12, 10-12(Dec. 1960). (In Russian)

In children subjected to irradiation for fungal diseases of the scalp there were found considerable shifts in the state of the vegetative nervous system which remained stable for a long-term period after discontinuation of the ionizing radiation effect. (auth)

12751 THE DYNAMICS OF UNSATURATED FATTY ACIDS IN THE BLOOD OF PATIENTS SUBJECTED TO RADIUM THERAPY. V. V. Nikolskii, N. A. Nekovaleva, and L. M. Chumakova (Rostov Inst. of Medicine, USSR). Med. Radiol., 5: No. 12, 13-17(Dec. 1960). (In Russian)

Studies were done on 14 patients subjected to telegammatherapy on a GUT-Co-400 apparatus and 3 in 30 healthy individuals. In the process of telegammatherapy there was noted a decrease of the general content of fatty acids, especially unsaturated ones. After the end of treatment a reverse picture was observed. (auth)

12752 ON THE MECHANISM OF INFLUENCE ON THE BACTERIOPHAGE IN INDIRECT ACTION OF IONIZING RADIATION. G. E. Fradkin, D. M. Goldfarb, B. N. Ilyashenko, A. V. Avdeeva, and Yu. P. Vinetskii (Vinetsky) (Gamalei Inst. of Epidemiology and Microbiology, Academy of Medical Sciences, USSR). Med. Radiol., 5: No. 12, 36-42(Dec. 1960). (In Russian)

The results are given of investigations pertaining to the nature of influence of indirect gamma-radiation on the antigenic, adsorptive, lythic and reproductive functions of B. coli phage. It was found that in indirect ionizing radiation effect the regularity of functional affection of the virus particle is similar to that of direct irradiation action. (auth)

12753 THE METABOLISM OF LIPIDS IN RADIATION SICKNESS. V. A. Shaternikov. Med. Radiol., 5: No. 12, 61-8(Dec. 1960). (In Russian)

The physiological aspects of radioinduced disturbances in lipid exchange are reviewed considering the participation of organs and tissues. The physico-chemical aspects of alterations in fats are not discussed. Extensive bibliographies are included. (R.V.J.)

12754 THE EFFECT OF PERFUSATE FROM IRRADIATED TISSUES ON THE BACTERICIDAL PROPERTIES OF THE SKIN AND PHAGOCYTIC ACTIVITY OF LEUKOCYTES. A. G. Sverdlov. Med. Radiol., 5: No. 12, 73-4(Dec. 1960). (In Russian)

The results of intravenous injections of 70 to 80 ml of perfusate from the irradiated hip of a rabbit into 16 rabbits show depressive effects on the bactericidal properties of the tissue and simultaneous depressions of phagocytic activity of neutrophyles (on the third day the index was reduced 18%; on the fifth and seventh day it was down to 16.5%). The restoration of phagocytic activity begins during the 3rd week and restoration of the properties of bactericidal tissue takes place after 14 to 16 days. (R.V.J.)

12755 CHANGES IN RADIORESISTANCE OF SPORULATING CELLS OF BACILLUS CEREUS. Vladimir Vinter (Inst. of Biology, Czechoslovak Academy of Sciences, Prague). Nature, 189: 589-90(Feb. 18, 1961).

A study of sporulating cells of Bacillus cereus showed that radioresistance appears simultaneously with the formation of cystine structures. Data are tabulated and possible reaction mechanisms are discussed. (C.H.)

12756 SHORTENING OF LIFE AND CAUSES OF DEATH IN MICE EXPOSED TO A SINGLE WHOLE-BODY DOSE OF RADIATION. Patricia J. Lindop and J. Rotblat (St. Bartholomew's Hospital Medical Coll., London). Nature, 189: 645-8(Feb. 25, 1961).

Results are reported from a systematic investigation on the reduction of life-span and causes of death in mice exposed at the age of 30 days to a single whole-body dose of 15-Mev x radiation. Dose levels ranged from 100 to 800 r. A quantitative relation was demonstrated between shortening of life and dose. A full post-mortem examination was carried out on each animal that died to try to establish the cause of death. It was concluded that the shortening of life produced by radiation is due to the hastening of all causes of death rather than the induction of a specific disease. (C.H.)

12757 INFLUENCE OF HYPOTHERMIA ON THE SURVIVAL OF MICE AFTER LARGE DOSES OF X-RADIATION. L. Mraz and M. Praslicka (Safarik Univ., Kosice, Czechoslovakia). Nature, 189: 677-8(Feb. 25, 1961).

Hypothermia was found to prolong the mean survival time of irradiated mice and reduce the effective dose of radiation significantly. Reaction mechanisms involved are discussed. (C.H.)

12758 DIFFERENTIAL RADIOSENSITIVITY IN RICE (ORYZA SATIVA LINN.) AT THE GENOTYPIC LEVEL. H. K. Shama Rao and K. C. Bora (Atomic Energy Establishment, Trombay, India). Nature, 189: 762-3(Mar. 4, 1961).

During studies of radiation effects on rice, advantage was taken of an anthocyanin pigmented mutant appearing as a heterozygote for albinism in N_1 population of a variety GEB-24 to study the relative radiosensitivity of genotypes at this locus. N_2 seedlings of the mutant segregated into greens and albinos in a 3:1 ratio. The genes for albinism behaved as simple recessive to normal green. In one test, dry seeds from the heterozygous N_1 plant were irradiated with 5 to 40 kr x rays at 309 r/min. In the second experiment, seeds from the N_1 plant and seeds from the N_2 progeny, known to be homozygous dominant for green, were irradiated to 10 to 50 kr at 650 r/min. It was found that doses above 20 kr had increasing effects on the rate of reduction of number of seedlings in both experiments. With high doses the 3:1 ratio was affected giving 9:1 and 9.5:1 at 40 kr; this was due to the greater lethality in the albinos. The seeds carrying the recessive condition were more radiosensitive than the other two genotypes. It is of further interest to note that a difference existed between the hetero- and homozygotes for green in their radiosensitivity. (T.R.H.)

12759 FIBROSARCOMA IN A RABBIT FOLLOWING β-IRRADIATION OF THE SKIN. L. A. George, S. Marks, and L. K. Bustad (General Electric Co., Richland, Wash.). Nature, 189: 770-1(Mar. 4, 1961).

The gross and histologic appearance are described of a fibrosarcoma which formed 4 yr after the exposure of an area of rabbit skin to 16,000 rads from a P^{32} plaque. The primary tumor occurred at the site of the original β irradiation. (C.H.)

12760 VISCOSITY OF THE THYMUS DESOXYRIBONUCLEIC ACID IN X-IRRADIATED RATS. Ulrich Hagen (Heiligenberg-Institut, Heiligenberg, Ger.). Naturwissenschaften, 47: 601(1960). (In German)

The viscosity of desoxyribonucleic acid in a total extract of the thymus was determined to detect the low-molecular fractions of DNA. The research animals were rats irradiated with 200-kv x radiation to 800 r. The specific viscosity was determined at 21.0°C at a concentration of 0.2 mg DNA/ml. The results are tabulated and show a degradation of the DNA. The viscosity of the thymus extract showed a significant variation only 4 hr after the irradiation. The mechanism for the degradation was discussed. (J.S.R.)

12761 THE OXYGEN-EFFECT FACTOR FOR RAT POPLITEAL LYMPH NODES IRRADIATED IN VIVO. Ruth Moore (Radiobiological Research Unit, Cancer Inst. Board, Melbourne). Radiation Research, 14: 296-307(Mar. 1961).

The oxygen-effect factor for rat popliteal lymph nodes irradiated in vivo was determined. Mean dose rates in tissue were 338 r/min for popliteal node experiments (local irradiation) and 152 r/min for lumbar and popliteal nodes in whole-body irradiation experiments. Attempts were made to produce anoxia in three ways: by clamping the aorta, by irradiating animals breathing pure N_2, and by applying external pressure to the aorta through an inflated rubber tourniquet encircling the abdomen. The oxygen-effect factor was calculated by plotting the product of the pyknotic count against the log dose rate and calculating regression equations. The relative radiosensitivities of lumbar and popliteal nodes were estimated from pyknotic counts of smears prepared at various times after a whole-body dose of 1000 r. The oxygen-effect factor was found to be 3.55. Deep barbiturate anesthesia caused a reduction in lymphocyte pyknosis 4 hr after irradiation, whether administered prior to or immediately after irradiation. (M.C.G.).

12762 EFFECTS OF pH AND ANOXIA ON THE CELL MORPHOLOGY AND X-RAY SENSITIVITY OF ESCHERICHIA COLI. Thornton Sargent, III (Univ. of California, Berkeley). Radiation Research, 14: 323-36(Mar. 1961).

Anaerobic glucose cultures of E. coli were grown at a controlled basic pH and compared to cultures grown without pH control, which became acid. The radioresistance of these cells was changed markedly, and to determine whether this was due to different pH during culturing or during irradiation the effect of pH during irradiation was studied separately. All growth and plating media that were controlled as to hydrogen ion concentration were adjusted by addition of phosphates or phosphoric acid. It was found that the apparent protection of anaerobic growth could be largely abolished by causing growth to occur in alkaline rather than the usual acid conditions. It was found by observation under phase contrast and by DNA analysis that the usual anaerobic acid growth produces multinucleate cells. Alkaline growth, however, produces cells of lower nuclear multiplicity. The "protection" conferred by anaerobic acid growth can thus be attributed to nuclear multiplicity and not to anoxia during irradiation (M.C.G.)

12763 A NONMONOTONIC PROTEIN-CHARACTERIZING FUNCTION OF IONIZING RADIATION DOSE. John W.

Preiss and Alvin G. McNish (National Cancer Inst., Bethesda, Md.). Radiation Research, 14: 337-48(Mar. 1961).

A nonmonotonic function of ionizing radiation dose was found which is characteristic for basic proteins. This function is an excess turbidity which the dry, in vacuo-irradiated proteins induce in RNA (or DNA) solutions. The derivative of this function can vanish for one or more infinite dose values. The position of the roots of the derivative equation was found to depend on the relative magnitudes of the turbidity induction classes at a given pH. The division into these classes was made analytically, on the basis of the number of primary ionizations experienced by the protein molecules. (auth)

12764 INTERACTION OF CHROMATID BREAKS PRODUCED BY X-RAYS AND RADIOMIMETIC COMPOUNDS. Timothy Merz and C. P. Swanson (Johns Hopkins Univ., Baltimore). Science, 133: 703-5(Mar. 10, 1961).

The results of combination treatments of the roots of V. faba with certain radiomimetic compounds (8-ethoxycaffeine, maleic hydrazide, β-propiolactone, and potassium cyanide) and x ray, as well as combination treatments of certain radiomimetic compounds with one another, were observed to determine whether interaction will occur between chromosomal breaks induced by different agents. Interaction was observed between breaks induced by x rays and all of the breaks induced by chemicals but not between breaks induced by any two chemicals. The results are discussed in terms of possible breakage bond differences and the effects of temporal and spatial differences in breaks induced by different agents. (auth)

12765 FACTORS INFLUENCING RADIATION INDUCED MUTATIONS IN PLANTS. Howard J. Curtis (Brookhaven National Lab., Upton, N. Y.). Trans. Bose Research Inst., Calcutta, 22: 17-24(1958). (In English)

The ways in which radio-induced mutations in plants are produced and the possibilities for increasing the rate of mutation are discussed. It was found that the number of mutations is directly proportional to the radiation dose. Two general methods for producing mutations in woody plants were tried. The first was to grow the material at some distance from the source so it could grow well for a long period of time but still be under the influence of radiation. The other method was to plant them close to the source, leave them for about 3 years, and then transplant them to a normal field. In irradiations of seeds it was found that the moisture content of the seeds, oxygen tension, temperature, and length of storage had pronounced effects on the rate of mutations and damage induced by x rays but had no effect on that induced by neutron bombardment. (M.C.G.)

12766 COMPARATIVE INVESTIGATIONS OF THE RADIATION SENSITIVITY OF BACTERIUM COLI AND YEAST ESPECIALLY IN APPLICATION OF ENERGETIC BEAMS. K. Sommermeyer and H. Magnus (Universität, Freiburg i. B. and Röntgeninstitut der Städt. Krankenanstalten, Karlsruhe, Ger.). Z. Naturforsch., 15b: 770-8(Dec. 1960). (In German)

For testing the hypotheses originated by Dobson (deuteron research with B. coli), by Houtermans (temperature research with B. coli), and by Alper (analyses of the RBW factor in yeast) that B. coli in the presence of energetic radiation is killed for the most part by radioinduced inactivating substances (IS) with large diffusion lengths and that yeasts are killed by a direct hit in the vital substances, a comparative investigation of the radiation sensitivity of B. coli and haploid yeast cells was made. The assumptions of Dobson, Houtermans, and Alper could therefore be confirmed. On going below the freezing point and by exposure to α radiation, B. coli shows, in agreement with Houtermans' findings, a jump-like increase of $D_{1/2}$. Yeast shows, under the same conditions, only a gradual increase. B. coli can be almost completely killed by diffusable IS which are formed by uv in very high doses in agar, whereas yeast cells with the same radiation sensitivity exhibit no effect. After irradiation of the agar both with uv and with energetic radiation, at high dose rates, diffusable IS with short life ($T_{1/2}$ up to about 15 sec) can be detected. The reaction mechanism for the origin of this IS (multi-collision reactions) and for its destruction in agar is shown to be extremely complicated. The diffusion length of the IS in agar was determined to be about 80 μ and its diffusion coefficient about 0.6×10^{-5} cm^2/sec. This corresponds to a mean molecular weight of about 200. The ion yield in the IS formation is strongly dependent on the O_2 concentration for x radiation and is independent for α radiation. If the agar is in the open atmosphere, the ion yield for α radiation is 10 times greater than for x radiation. The number of IS molecules diffusing to coli cells, which are necessary for destruction, is divided by the ion yield in its origin for x radiation by a factor of 10^9. (tr-auth)

12767 ERBLICHE SCHADEN DURCH IONISIERENDE STRAHLEN. (Hereditary Effects of Ionizing Radiation). Richard Focke. Leipzig, Veb Georg Thieme, 1959. 78p.

The genetic effects of radiation are discussed in some detail to point out the increasing danger from widespread use of radiation sources and devices. Some of the topics included are: danger from natural and artificial sources, spontaneous mutation, the mutation rate, methods for calculating mutations, artificially induced mutations, atomic-explosion induced mutations, and industrial injuries. (T.R.H.)

12768 CHEMICAL PROTECTION TO MAMMALS AGAINST IONIZING RADIATION. David G. Doherty (Oak Ridge National Lab., Tenn.). p.45-86 of "Radiation, Protection and Recovery." New York, Pergamon Press, 1960.

The concept of chemical protection against radiation injuries is based on the premise that, in some manner, the presence of the chemical in the system at the time of irradiation reduces or prevents radiation damage. It is assumed that the major damage to the mammal from low-level radiation is caused by the free radicals produced in irradiated water. It is pointed out that many of the conflicting and variable results that have been reported are caused by wide differences in irradiation techniques, dosimetry, and animal handling. Representatives of almost every type of substance, from simple gases and inorganic and organic compounds to complex biological materials such as hormones, vitamins, and dietary factors, have been tested for protective activity against radiation damage. Many have been claimed to be partially effective. Since testing procedures vary widely, it is difficult to evaluate these claims properly. The materials are divided into three groups: compounds that may produce some type of anoxia, sulfhydryl compounds, and miscellaneous protective agents. The effects of anoxia, cysteine, glutathione, mercaptoethylamine, aminoalkylisothioureas and mercaptoalkylguanidines, and miscellaneous compounds such as fats and vitamins, amines, sulfur-containing compounds, anesthetics and tranquilizers, and various polymers on radiation injuries are discussed. Possible reaction mechanisms involved in the protective action are considered. 248 references. (C.H.)

12769 PROTECTION AND RECOVERY IN BACTERIA AND FUNGI. G. E. Stapleton (Oak Ridge National Lab., Tenn.). p.87-116 of "Radiation, Protection and Recovery." New York, Pergamon Press, 1960.

Mechanisms involved in the biological effects of ionizing

radiations in bacteria and fungi are reviewed. Topics discussed include the effect of cultural conditions and physiological state on radiosensitivity, factors that modify radiosensitivity, role of the phase state in inactivation, the effects of the gaseous environment during irradiation, chemical protection against inactivation and mutation, and recovery from radiation damage. 79 references. (C.H.)

12770 PROTECTION AND RECOVERY OF THE CELL FROM RADIATION DAMAGE. Anna R. Whiting (Univ. of Pennsylvania and Oak Ridge National Lab., Tenn.). p.117-56 of "Radiation Protection and Recovery." New York, Pergamon Press, 1960.

Mechanisms involved in the production of radiation injuries in cells are discussed. Data are reviewed on the protection against radiation afforded by various treatments. It is pointed out that chemical and temperature protection must be studied from the point of view of their effects on the oxygen content of the cell before other factors can be considered. The question of the nature of radiation action in the cell has not been answered, but great progress has been made. 140 references. (C.H.)

12771 CHROMOSOME ABERRATIONS. Sheldon Wolff (Oak Ridge National Lab., Tenn.). p.157-74 of "Radiation Protection and Recovery." New York, Pergamon Press, 1960.

Radiation-induced chromosome aberrations may be modified by any procedure that can influence either the number of breaks primarily produced or the subsequent behavior of these breaks. Many of the modifying treatments seem to work through an effect on restitution of breaks. However, the oxygen effect apparently exerts its influence primarily on breakage. If one views the treatments that can diminish the aberration yield, those that decrease breakage or increase rejoining cannot easily be separated into protective or recovery agents. If a treatment is administered before and is effective during irradiation it is usually spoken of as a protective treatment. However, it may exert its effect not on the breakage of the chromosomes but on the subsequent restitution or recovery of the breaks. Conversely, a treatment applied after irradiation usually is termed a recovery treatment, yet, as in the case of the latent breaks, it can be seen that this might affect the breakage rather than the recovery mechanism of restitution. Data are summarized on the effects of various procedures that can decrease the genetic damage expressed as chromosome aberrations. All the methods listed are effective only for x- or γ-ray irradiation. In the case of the more densely ionizing neutrons or α rays, protection by these procedures has in the main been negative. One exception is that there is a slight oxygen effect with neutrons that is attributable to a decrease in breakage. The reason that the methods affecting restitution do not seem to change the aberration yield induced by neutrons is that, when an exchange is formed, these radiations almost always produce the two breaks with a single particle. The two-break aberrations, therefore, are one-hit and increase linearly with dose. It is inferred that the breaks are so close together that reunion occurs whether or not one can speed up the restitution process. Although, as yet, 100% protection against the production of chromosome aberrations has not been achieved, the studies with various modifying factors have accomplished two important things. First, they have given a great deal of information about the actual nature of the damage induced and, second, they have shown that some procedures can be used to modify radiation-induced genetic damage. 65 references. (auth)

12772 PROTECTION AND RECOVERY FROM IONIZING RADIATION: MECHANISMS IN SEEDS AND ROOTS. D. Davidson (Oak Ridge National Lab., Tenn.). p.175-211 of "Radiation, Protection and Recovery." New York, Pergamon Press, 1960.

Mechanisms involved in the protection and recovery of seeds and roots from the effects of ionizing radiations are summarized. Topics discussed include the direct effects of radiation on growing roots, growth of irradiated roots, the site of damage, the effects of direct radiation exposure on seeds, factors that may modify the effects of radiation, and a comparison of the effects of radiations of different linear energy-transfer values. 178 references. (C.H.)

12773 EFFECT OF RADIATION ON ANTIBODY FORMATION. T. Makinodan and N. Gengozian (Oak Ridge National Lab., Tenn.). p.316-51 of "Radiation Protection and Recovery." New York, Pergamon Press, 1960.

Studies on the effect of radiation on antibody formation led to the conclusion that x irradiation does not permanently destroy the immune mechanism of an animal; during the maximum depression period, a curvilinear relation exists between x-ray dose and antibody response; and x rays damage the mechanism for recognizing and responding to the genetically more closely related antigen more severely than it does for such a mechanism for a distantly related antigen. Furthermore, it was found that x irradiation can become a powerful tool for investigating the complex processes involved in antibody formation. On the cellular level in a normal animal, the events from antigen assimilation to antibody synthesis are not clearly known. The complex morphology of antibody-forming organs, with their ever-present nonantibody-forming hematopoietic cells, may be partly responsible. It is now feasible to observe cellular changes in a more innocuous background by merely transplanting known numbers of isologous nonsensitized antibody-forming cells into mice exposed to a lethal dose of x rays. 132 references. (auth)

12774 THE INFLUENCE OF X-RAYS ON THE SYNTHESIS OF HEMATIN FROM PROTOPORPHYRIN AND Fe-59 IN HEMOLYSIN OF THE MARROW CELLS OF RABBITS. Antoni M. Dancewicz and A. Mazanowska. p.726-9 of "Pierwsze Krajowe Sympozjum Poswiecone Stosowaniu Izotopow Promieniotworczych W Biologii, Medycynie, I Rolnictwie, 2 i 3 Kwietnia 1959, Warszawa." Warsaw, Bureau of the Atomic Energy Ministry, 1959. (In Polish)

The tracer isotope Fe^{59} was used to determine the amount of iron taken up by protoporphyrin of the marrow cells of rabbits. For the determinations, the marrow cells from two rabbits were always combined. The iron was in the form of a water solution of citrate of iron and the protoporphyrin preparation in diluted ammoniac. Penicillin and glucose were added and the test samples were incubated at 37°C while vibrated at 100 cycles per minute. After incubation, the hematin was isolated, the iron separated out, and its activity measured to determine the percentage of iron taken up. The inclusion of iron into protoporphyrin without radiation was first studied by systematically varying the following parameters: the amount of iron added, the amount of protoporphyrin added, and incubation time. Other factors such as the pH of the solution and effect of preheating the solution were also checked. A reasonable set of parameters was then chosen for the irradiation studies. The x-ray dosage applied to sets of samples ranged from 0 to 12,000 r. The amount of Fe^{59} in hematin decreased with increasing irradiation, but the rate of decrease became very small above a dose of 6000 r. The effect of ionizing radiation on the capability of incorporating iron into the hematin bonds is a useful tool in studying effects of ionizing radiation on iron-takeup in hemoglobin in living animals. (TTT)

Radiation Sickness

12775 (TID-12147) AN INVESTIGATION INTO THE PHARMACOLOGICAL PROPERTIES OF ANTI-IRRADIATION DRUGS. Progress Report and Proposal for Renewal of Contract. Victor F. DiStefano (Rochester, N. Y. Univ.). Mar. 16, 1961. Contract AT(30-1)-2192. 8p.

Progress is reported in an investigation of the physiological and pharmacological effects of chemicals whose ability to protect mice against radiation injury has been demonstrated. Pharmacological studies were carried out with 3,aminopropylisothiurea dihydrobromide (APT), 3,aminopropyl-N'-methyl isothiurea dihydrobromide (APMT), and mercaptoethylamine (MEA). AET was studied in detail, and preliminary results are presented. (C.H.)

12776 (USNRDL-TR-499) SPECIFIC HOMOGRAFT TOLERANCE IN LYMPHOID CELLS OF LONG-LIVED RADIATION CHIMERAS. L. J. Cole and W. E. Davis (Naval Radiological Defense Lab., San Francisco). Mar. 2, 1961. 24p.

(LxA)F_1 hybrid mice were exposed to an LD_{100} of x rays (870 r) and then injected intravenously with bone marrow cells from genetically foreign (homologous) normal C_3H strain mice. It was found that the long-term survivors were still chimeras, as evidenced by the presence in the spleen of transplantation immunity isoantigens specific for the marrow donor strain (C_3H). Immunological reactivity of lymphoid tissue cells from these chimeras was assessed by their capacity, when transferred to lethally x-irradiated (LxA)F_1 mice, to cause the rejection of homologous bone marrow. These chimera lymphoid cells brought about the rejection of marrow transplants derived from normal DBA/2 or BALB/c mice strains that are genetically foreign with respect to both the donor and host genotype of the chimeras. However, lymphoid cells from the chimeras were found to be nonreactive, i.e., tolerant, towards marrow transplants of (LxA)F_1 or of C_3H origin. Data are presented which indicate strongly the presence of immunologically reactive cells of donor (C_3H) genotype in the lymphoid tissues of these long-lived chimeras. It is suggested that a state of mutual homograft tolerance exists between the donor and host lymphoid cells in these long-lived radiation chimeras although these cells reject grafts of cells which are homologous to both donor and host type. The implications of these findings as they relate to the phenomenon of actively acquired tolerance and to the clonal selection theory of immunity are discussed. (auth)

12777 THE THYROID GLAND FUNCTION IN ACUTE RADIATION SICKNESS. T. G. Baramidze (State Graduate School of Medicine, Georgian, SSR). Med. Radiol., 5: No. 12, 32-6(Dec. 1960). (In Russian)

Dynamic studies were conducted by the method of radioactive indicators for the assessment of the thyroid gland function in rabbits with acute radiation sickness. The radiation sickness, induced by whole-body x-ray irradiation with a dose of 600 r, ran a more severe course than in rabbits subjected to the internal action of radiophosphorus in a dose of 600 r. In rabbits of the first group (x-ray irradiation) at the 20th and 48th day of the disease the function of the thyroid gland drops down to 4 to 8% of maximal inclusion (initial 17 to 68%); toward the 76th day the thyroid function reverted to normal. In animals of the second group the thyroid function rises up to 29 to 36% (initial 12 to 14%); toward the 48th and 76th day the thyroid gland function gradually normalizes. (auth)

12778 ON THE NATURE OF INTERRELATIONSHIPS BETWEEN THE BLOOD PRESSURE, VASCULAR TONE AND BODY TEMPERATURE IN WHITE RATS WITH RADIATION SICKNESS. I. S. Kanfor. Med. Radiol., 5: No. 12, 71-2(Dec. 1960). (In Russian)

The blood pressure, vessel-tone, and temperature in radiation sickness and the influence of pharmacological substances on these factors were studied in 432 white rats exposed to a single whole-body irradiation of 1000 r. The obtained data indicate that protective effects are accomplished by temperature and cardiovascular factors. Moreover, the condition of the blood circulation apparatus and thermo-regulatory functions indicate the seriousness of the sickness and enable a prognosis. (R.V.J.)

12779 THE RESULTS OF EMPLOYMENT OF FOLIC ACID IN SUBACUTE RADIATION SICKNESS CAUSED BY THE CHRONIC ACTION OF X-RAYS. O. I. Belousova. Med. Radiol., 5: No. 12, 75-7(Dec. 1960). (In Russian)

Prophylactic treatments with 1 and 0.1 mg/kg folic acid three times a week for three weeks prior to irradiation did not affect the course of subacute radiation sickness. Therapeutic treatments with 1 mg/kg three times a week during radiation sickness contributed to the survival of guinea pigs. Treatments with 0.1 mg/kg three times a week, with 1 and 0.1 mg/kg daily, and with 1 and 0.1 mg/kg twice a week did not show positive results on survival. Disturbances in blood production were less pronounced in guinea pigs treated with folic acid than in control animals and the number of erythrocytes, leucocytes, and especially trombocytes was higher in pigs treated with folic acid after exposure to 600 r. (R.V.J.)

12780 THE EFFECT OF THYROIODINE ON RATS WHO HAD SUSTAINED ACUTE RADIATION SICKNESS. E. N. Antipenko. Med. Radiol., 5: No. 12, 77(Dec. 1960). (In Russian)

The effects of thyroiodine on thyroid gland function, resistance to infection, and erythropoiesis were tested in 281 rats weighing 260 to 300 g after irradiation with 850 r of γ radiation at 13.8 r/min. Thyroiodine (5 mg) was introduced orally, 90 days after exposure, twice a day for thirty days. The results indicated favorable effects, increasing two-fold the survival of rats in comparison to the controls, and improving the resistance to infection (B. perfringens). (R.V.J.)

12781 ON THE CHEMICAL PROTECTION IN ACUTE RADIATION INJURY. V. A. Razorenova. Med. Radiol., 5: No. 12, 78(Dec. 1960). (In Russian)

The introduction of amino-mercaptothiodiazole, acetylaminomercaptothiodiazole, and oxymethoxybenzophenone 20 to 25 min prior to exposure to 600 r increases the survival of rats to 50 to 70% as compared to 32 to 37% in controls and abates the course of radiation sickness. (R.V.J.)

12782 ASSESSMENT OF THE PREVENTIVE AND CURATIVE EFFECT OF PARATHYROID GLAND HORMONE ON THE IRRADIATED ANIMALS. E. R. Bagramyan. Med. Radiol., 5: No. 12, 78-9(Dec. 1960). (In Russian)

Experiments carried out with 4-week-old, 50 to 70-g rats, and 170 to 180-g, fully grown rats treated with daily doses of parathormone before and after exposure to lethal and sublethal x irradiation show that treatment with 20 to 200 units of parathormone does not alter the mean life span or survival. (R.V.J.)

12783 VIRAL AND BACTERIAL PULMONARY INFECTION IN ANIMALS WITH DIFFERENT FORMS OF RADIATION INJURIES. V. P. Emaikina. Med. Radiol., 5: No. 12, 79-80(Dec. 1960). (In Russian)

Morphological features of virus influenza and pulmonary bacterial streptococcus and staphylococcus infection in mice irradiated with 200 to 1000 r were studied in 1758

mice weighing from 18 to 22 g. An increased penetration of cell and vessel membrane and depressed inflammatory reactions were observed in animals exposed to 600, 800, and 1000 r. (R.V.J.)

12784 THE SPECIFIC FEATURES IN THE PICTURE OF LEAD POISONING IN RATS WHO HAD SUSTAINED RADIATION INJURY. Zh. I. Abramova and G. N. Kuz'minskaya. Med. Radiol., 5: No. 12, 80-1(Dec. 1960). (In Russian)

Compensatory hematopoietic reactions to lead poisoning were studied in 123 male rats 1 to 3 months after whole-body irradiation with 300 r and exposure for 24 days to lead poisoning (daily doses of 0.3 ml of 40% solution per 100 g weight). The irradiated animals exhibited a higher resistance to toxic anemia and a much more rapid development of young cells in the peripheral blood. However, along with increased erythropoiesis were observed increased disturbances in the bone marrow and greater degenerative-dystrophic changes in the spleen and liver. (R.V.J.)

12785 NEURAL TISSUE AND PULMONARY LESIONS IN NORMAL AND IRRADIATED RATS INJECTED WITH HOMOGENIZED HOMOLOGOUS LUNG TISSUE MIXED WITH FREUND'S ADJUVANT. N. Allegretti and B. Vitale (Ruder Boskovic Inst., Zagreb). Nature, 189: 673(Feb. 25, 1961).

Experimental allergic encephalomyelitis was induced in irradiated rats. The specificity of the reaction was studied following injections of homogenized homologous lung tissue mixed with adjuvant. Data are tabulated and results are discussed. (C.H.)

12786 PROTECTIVE ACTION OF CALCIUM GLUCONATE AGAINST AFTER-EFFECTS OF X-IRRADIATION ON CONIDIA OF NEUROSPORA CRASSA. J. Weijer (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nature, 189: 760-1(Mar. 4, 1961).

The addition of calcium gluconate to the plating medium increased the survival of coidia of Neurospora crassa following exposure to x radiation. Evidence is presented which indicates that calcium is a potential protector against radiation death in yeast and that the protection is associated with the prevention of radiation-induced increase in cell permeability. (C.H.)

12787 PROTECTIVE EFFECTS OF DIISOPROPYLFLUOROPHOSPHONATE AGAINST THE LETHAL EFFECTS OF X-RAYS BEFORE OR AFTER IRRADIATION. D. A. Willoughby (University Coll. Hospital Medical School, London). Nature, 189: 761-2(Mar. 4, 1961).

Treatment with diisopropylfluorophosphonate gave protection to rats against radiation injuries when given either before or after radiation exposure. (C.H.)

12788 DELETERIOUS EFFECTS OF HIGH FAT DIETS ON SURVIVAL TIME OF X-IRRADIATED MICE. Benjamin H. Ershoff (Western Biological Labs., Culver City, Calif.). Proc. Soc. Exptl. Biol. Med., 106: 306-9(Feb. 1961).

The effects of multiple sublethal doses of total body x-irradiation were determined on survival time of male mice fed either a purified fat-free ration or a similar diet supplemented with 2, 10, 20, or 30% cottonseed oil, margarine fat, or butter fat. The effects obtained were dependent on the amount and source of dietary fat. At levels of 2 or 10% of the diet, cottonseed oil and margarine fat increased survival time over that on the fat-free ration. When these fats were fed at higher levels (i.e., 20 or 30% of the diet), however, survival time was decreased below that obtained at the lower levels of supplementation. In contrast to the results obtained with the cottonseed oil or margarine fat supplements, butter fat at levels of 2 or 10% of the diet did not prolong survival over that on the fat-free ration; nor did it decrease survival time when fed at higher levels in the diet. (auth)

12789 THE MECHANISM OF ACTION OF AET. II. THE INTERACTION BETWEEN PROTEINS AND 2-MERCAPTOETHYLGUANIDINE AND BIS(2-GUANIDOETHYL) DISULFIDE IN AQUEOUS BUFFERED SOLUTIONS. E. Anne Dickens and Bernard Shapiro (Albert Einstein Medical Center, Philadelphia). Radiation Research, 14: 308-22(Mar. 1961).

The binding of 2-mercaptoethylguanidine (MEG) and the effects of γ radiation of aqueous solutions of 2-mercaptoethylguanidine-C^{14} (MEG-C^{14}) and bis(2-guanido-C^{14}-ethyl) disulfide (GED-C^{14}), or 2 mercapto-S^{35}-ethylguanidine (MEG-S^{35}) and bis(2-guanidoethyl) disulfide-S^{35} (GED-S^{35}), and proteins are discussed. The radioactive species present before and after irradiation of aqueous buffered solutions of MEG-C^{14} and GED-C^{14}, or MEG-S^{35} and GED-S^{35}, and proteins were identified by means of paper strip chromatography and paper electrophoresis. The protein-MEG-C^{14} complexes formed were isolated both by dialysis and by passage through a column of Sephadex. In solution, the complexes were cleared by the addition of thiols and disulfides. Guanidine, ethylamine, and taurocyamine also displace a small amount of MEG from the complex. Irradiation of aqueous, buffered solutions of MEG and GED containing high protein concentration produced no detectable oxidation product of GED. The amount of protein-bound MEG increased considerably. Cleavage of irradiated complexes was more difficult than cleavage of the nonirradiated complex. (M.C.G.)

12790 EXPERIMENTAL TREATMENT OF ACUTE WHOLE-BODY RADIATION INJURY IN MAMMALS. L. H. Smith and C. C. Congdon (Oak Ridge National Lab., Tenn.). p.242-302 of "Radiation Protection and Recovery." New York, Pergamon Press, 1960.

The pathogenesis of acute radiation death in mammals is reviewed. Modifications of acute radiation damage in mammals with transplantation of hematopoietic tissue are discussed. In general, the approach described is based on the concept of transplanting normal tissues and cells to replace those damaged by the exposure. It is pointed out that in the sublethal and midlethal exposure ranges, spontaneous recovery of bone marrow can be supported therapeutically by tiding-over measures such as antibiotics and blood transfusions. Tiding-over techniques constitute an important practical aspect of the therapy of radiation injury. One of the unique features of transplantation of hematopoietic tissues is the intravenous route of administration. The effectiveness of isologous bone marrow is compared with results using heterologous bone marrow. Shielding procedures and their effects on radiosensitivity, the nature of transplanted hematopoietic tissue, cell types responsible for repopulation, bone marrow cell dose, routes and time of injection, the preservation and tissue culture of bone marrow, and reactions of irradiated mammals to homologous or heterologous bone marrow treatment are discussed. Experimental and clinical applications are reviewed. 347 references. (C.H.)

CHEMISTRY

General and Miscellaneous

12791 (APEX-187(Del.)) U_3O_8 SINGLE CRYSTALS. Wendell B. Wilson (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Jan. 31, 1955. Contracts AF33(600)-38062 and AT(11-1)-171. 9p.

Single crystals of a nominal U_3O_8 composition were found to occur during recovery of U_3O_8 from the GE-ANPD Teflon fuel elements. These crystals were examined by x-ray diffraction using Weissenberg and precession techniques. Translation about the three crystallographic axes of the orthorhombic unit cell gave an approximate cell size of: a = 11.58 ± 0.02; b = 7.06 ± 0.02; and c = 8.30 ± 0.02 A. This unit cell is intimately related to the Zachariasen U_3O_8 unit cell. A pseudo cell is indicated as previously reported for oxides in this range. Examination under polarized light indicated that flat platelets of the crystals were usually twinned, but those which grew parallel to the "c" axes were frequently good crystals. This material was reduced at 1000°C under a hydrogen atmosphere to UO_2 with the pseudohexagonal U_3O_8 crystal shape being retained. Examination of the UO_2 "crystals" by Weissenberg techniques showed that they were actually polycrystalline. (auth)

12792 (NP-9646) ON THE REACTION OF CHROMATES WITH DIPHENYLCARBAZIDE. J. Minczewski and W. Zmijewska (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). May 1960. 20p. (PAN-153/VIII)

Reactions of Cr(VI) with diphenylcarbazide and Cr(II) with diphenylcarbazone (DPCN) were investigated spectrophotometrically and by potentiometric titration. The investigations concerned the course the reactions run with an excess of the reagents, conditions of extraction of the colored product, and the behavior of DPCN in solutions of organic and mineral acids. A mechanism is proposed for the reactions. (auth)

12793 (NYO-3279) THIRD ANNUAL REPORT ON DISTRIBUTION STUDIES BETWEEN MELTS AND SOLID PHASES USING RADIOACTIVE TRACERS. R. Ward, W. C. Orr, L. Katz, H. A. Bent, J. J. Casey, J. T. Looby, H. Bellis, and C. Gallagher (Connecticut. Univ., Storrs). July 31, 1954. Contract AT(30-1)-1154. 33p.

The distribution of Ce(III) between molten $BaCl_2$ and solid $BaZrO_3$ in vacuo at 1000°C was studied. Radiotracer experiments in which cerium ranged in concentration from 10^{-13} to 18.7 at.% of the cerium–zirconium content showed that essentially none of the cerium remained in the molten phase. X-ray examination of the insoluble residue from the experiments showed the presence of monoclinic and tetragonal zirconia and a third phase identified as $Ce_2O_3 \cdot 2ZrO_2$. The major reaction occurring in the system was concluded to be $3BaZrO_3 + 2CeCl_3 \rightarrow Ce_2O_3 \cdot 2ZrO_2 + 3BaCl_2 + ZrO_2$. A new ternary oxide of yttrium and chromium was prepared and its formula and density determined. Its x-ray powder pattern can be indexed on the basis of a monoclinic cell. This compound and $LaCrO_3$ were used as solid phases in preliminary work on the investigation of common ion and foreign ion exchange phenomena. Yttrium 90 was separated from its parent strontium 90 by ion exchange for tracer use in these studies. From a thermodynamic point of view, the problem of predicting the distribution of trace ion between solids and melts is one of evaluating ΔF° for the exchange reaction by which equilibrium is attained. A summary of the literature was made with this in mind, and several methods for resolving and evaluating ΔF° are proposed. (For preceding period see NYO-3277.) (auth)

12794 (ORNL-3021) SELF-SUPPORTED CYCLOTRON TARGETS OF BORON AND MAGNESIUM. G. R. Hoke and E. Newman (Oak Ridge National Lab., Tenn.). Mar. 1, 1961. Contract W-7405-eng-26. 7p.

Production methods are described for self-supporting 25 to 100 $\mu g/cm^2$ film radiation targets of B^{10} and Mg^{24}. (J.R.D.)

12795 (TID-11188) LOW TEMPERATURE CHEMICAL THERMODYNAMICS PROJECT. Technical Progress Report No. 8 [for] November 1959–November 1960. Edgar F. Westrum, Jr. (Purdue Univ., Lafayette, Ind. Physics Dept.). 33p. Nov. 25, 1960. Contract AT(11-1)-70.

Heat capacity measurements were made on two sulfur derivatives of adamatane, triethylenediamine, uranium disulfide and uranium trisulfide, and on chromium tellurides, quartz, cristobalite, vitreous silica, transition element hexafluorides, and ammonium perchlorate. The thermodynamic properties of rare earth sesquioxides are being investigated. (W.L.H.)

12796 (TID-11818) A FUNDAMENTAL STUDY OF THE IODINE–SILVER NITRATE REACTIONS. Progress Report, January 1, 1960–December 31, 1960. Report No. 3. Charles E. Dryden and James C. Leslie (Ohio State Univ. Research Foundation, Columbus). Jan. 196[1]. Contract AT(11-1)-750. 41p.

A study of the basic chemical and physical properties of silver nitrate–iodine systems was continued. An experimental apparatus was built and tested successfully for the measurement of the rate of reaction of gaseous iodine with solid silver nitrate, using I^{131} tracer to measure the amount of material reacted and the depth of penetration. Work is in progress to obtain kinetic data for this system as a function of temperature and pressure. The possible adaptation of this gaseous tracer method to other two- and three-phase systems is pointed out. (auth)

12797 (TID-11885) THE BEHAVIOR OF ELEMENTS AT VERY LOW CONCENTRATIONS. Progress Report No. 2. Milton Kahn [(New Mexico. Univ., Albuquerque)]. [nd]. Contract AT(11-1)-733. 10p.

A volatilization study was made of the carrier-free cathodic deposit of Pb^{212}. The rate of dissolution of "active deposit" preparations and electrodeposited Pb^{212} was studied. Varibles studied were dissolution media, surface conditions, and treatment of the samples prior to dissolution. In almost all cases, a 12 to 18% fraction exhibited extreme resistance to removal. The rate of the isotopic exchange reaction between arsenic(III) and arsenic(V) in aqueous HCl was found to depend on the age of the stock solutions. The effects of the hydrochloric acid concentrations on the ultraviolet absorption spectra of the arsenic ions was investigated. (M.C.G.)

12798 (TID-11888) THE ISOTOPE EFFECT IN THE STUDY OF CHEMICAL REACTIONS. Progress Report, January 16, 1960 to January 15, 1961. Ernest M. Hodnett, Ray D. Taylor, Donald A. Holmer, Charles R. Williams, Mary N. Williams, Robert Walston, Charlene Weaver, and Robert A. Taylor (Oklahoma State Univ., Stillwater). Contract AT(11-1)-71. 20p.

The isotope effect was studied in several reactions, and the effects were interpreted in terms of the reaction mechanism and the structures of the molecules involved. The postulation of a common transition state in the alkylation of ambident anions was tested. In a study of the mechanism of condensation polymerization, the kinetics and isotope effects in the reactions of phthaloyl chloride with piperazine and with 4,4'-isopropyl-idenediphenol were studied. From these data a mechanism of interfacial polymerization was proposed. The rates of oxidation of substituted benzyl alcohols were studied with T-labeled molecules. Isotopic effects were studied in the decomposition of dichlorofluoroacetic acid, in the reduction of halides with lithium aluminum hydride, in the free-radical arylation of benzene, and in the oxidation of cyclohexanol with vanadium. (M.C.G.)

12799 (TID-11935) THE DIFFERENCE EFFECT AND ANODIC BEHAVIOR OF HAFNIUM DISSOLVING IN HYDROFLUORIC ACID. Progress Report [on] CORROSION OF NUCLEAR METALS. W. J. James, M. E. Straumanis, and J. W. Johnson (Missouri. Univ., Rolla. School of Mines and Metallurgy). 1961. Contract AT(11-1)-73. 17p.

Crystal bar hafnium dissolving in HF in the presence of HCl exhibited a positive difference effect similar to that previously observed for zirconium dissolving in HF. The effect was so pronounced that the hydrogen volume developed by the internal polarization current was overbalanced and the rate of self dissolution by an additional 3 mm^3 cm^{-2} min^{-1} of hydrogen was reduced. The effect was accompanied by a strong shift of the hafnium electrode toward noble values. Similar potential changes were observed upon the addition of noble metal salts to the acid mixture; the rate of dissolution dropped to zero with Pt^{4+} additions in HF alone but only slightly in HF–HCl. The results of the difference effect studies, together with rate measurements in HF–HCl, appeared to confirm a previous conclusion with regard to the high rate of dissolution of zirconium: The dissolution rate is brought about by the direct chemical action of molecular HF. Possible explanations are given for the slight increase of metal dissolution in the presence of HCl additions. (auth)

12800 (AEC-tr-4423) INTERACTION BETWEEN THE CHLORIDES OF RARE-EARTH METALS AND CHLORIDES OF ALKALI AND ALKALI-EARTH METALS. Yin-Chu Sung (In'-chzhu Sun) and I. S. Morozov. Translated by Lydia Venters (Argonne National Lab.) from Zhur. Neorg. Khim., 3: 1914-24(1958). 15p.

Phase diagrams are presented for a large number of binary systems and one ternary system containing one or more each of the La, Ce, and Nd chlorides and of the K, Cs, and Mg chlorides. The binary systems studied were: $LaCl_3$-KCl, $CeCl_3$-KCl, $NdCl_3$-KCl, $LaCl_3$-CsCl, $CeCl_3$-CsCl, $NdCl_3$-CsCl, and $CeCl_3$-$MgCl_2$. Compounds of the type M_3RCl_6 and K_2RCl_5 were detected in the binary systems, where M = K and Cs and R = rare-earth metal. The ternary system studied was $CeCl_3$-$MgCl_2$-KCl; three ternary nonvariant points were found. (D.L.C.)

12801 (AEC-tr-4462) METAL MEMBRANES. N. V. Kultaschev and F. A. Santalov. Translated from Z. anorg. u. allgem. Chem., 223: 177-84(1935). 15p.

The preparation and behavior of metal membranes with reversible potentials are discussed. Included is a description of diffusion experiments and electrometric studies of copper membranes. (J.R.D.)

12802 (CEA-tr-R-1078) DOSAGE DE L'ACIDE LIBRE EN PRÉSENCE DE DIFFÉRENTS SELS. (Determination of Free Acid in the Presence of Different Salts). M. M. Senyavin (Seniavine) and A. M. Sorochan. Translated into French from Trudy Komissii Anal. Khim., Akad. Nauk S.S.S.R., Inst. Geokhim. i Anal. Khim., 7: 246-71(1956). 38p.

An attempt is made to compare the different methods of determination of free acids in the presence of a group of unknown and variable salts. The methods were tested by simultaneous measurement of pH and electric conductivity. The distillation and extraction methods are not as useful because of hydrolysis of the salts, variation of the coefficient of distribution, and variation of the solution composition. Considerable data on the interfering elements for the titration method are given. The best method involves precipitation of the interfering elements by oxalates and ferrocyanides, with the addition of chlorides for potentiometry of fluorides for colorimetry. (T.R.H.)

12803 (NP-tr-568) A STUDY OF EQUILIBRIUM IN THE REDUCTION OF BERYLLIUM OXIDE WITH CARBON AT HIGH TEMPERATURES. F. Sh. Muratov and A. V. Novoselova. Translated from Doklady Akad. Nauk S.S.S.R., 129: 334-6(1959). 6p.

The equilibrium in a beryllium oxide-carbon system was studied using the manometric method in the range 1673 to 2273°K. After the reaction, the reaction products were subjected to chemical and x-ray analyses. Equilibrium pressures could be attained only in the range 1700 to 1950°K, and the reaction products in this range were found to contain Be_2C, BeO, and C. The temperature dependence of ΔF for the reaction $BeO(s) + \frac{3}{2} C(s) \rightarrow \frac{1}{2} Be_2C(s) + CO(g)$ was found to be 50864-19.22 T in this range. At higher temperatures, the CO pressure at first reaches a maximum and then decreases sharply, never reaching a definite value; and the reaction products corresponding to the pressure decrease consist of almost pure carbon. A sublimate forms on the cold parts of the heater, which was found to be a new phase. The reactions occurring in the 1950 to 2250°K range are postulated to be $Be_2C(s) \rightarrow 2\ Be(g) + C(s)$ and $Be(g) + CO(g) \rightarrow BeO(s) + C(s)$. (D.L.C.)

12804 (NP-tr-572) SCIENTIFIC REPORTS OF HIGHER SCHOOLS, CHEMISTRY AND CHEMICAL TECHNOLOGY (SELECTED ARTICLES). Translated from Nauch. Doklady Vysshei Shkoly, Khim. i Khim., 1: 80-3; 84-7(1959). 19p.

Complete translations of two papers previously abstracted in NSA are included. (D.E.B.)

12805 (NP-tr-572(p.1-9)) THE EXTRACTION OF SALICYLATES OF SCANDIUM, YTTRIUM, CERIUM, LANTHANUM, URANIUM AND THORIUM. B. N. Sudarikov, V. A. Zaytsev, and U. G. Puchkov.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 264.

12806 (NP-tr-572(p.10-19)) THE FORMATION OF COMPLEX COMPOUNDS OF NEODYMIUM AND YTTERBIUM WITH ETHYLENEDIAMINETETRAACETIC ACID WITH CATION-EXCHANGING CHROMATOGRAPHY. L. I. Martynenko.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 148.

12807 ON THE STABILITY OF NITRATE AND CHLORIDE COMPLEXES OF PLUTONIUM(IV). Ingmar Grenthe

and Bertil Norén (Univ. of Lund, Sweden). Acta Chem. Scand., 14: 2216-29(1960). (In English)

The nitrate and chloride complexes of Pu^{4+} were studied in an acid perchlorate medium of ionic strength I = 4M at a temperature of 20°C by using the cation-exchanger method of Fronaeus. The calculation method was extended to systems of the type $M^{4+}-A^-$, where the central ion, the first, second, and third complexes can be sorbed on the ion exchanger. The complexity constants obtained for the nitrate system were $\beta_1 = 5.5 \pm 0.2\ M^{-1}$; $\beta_2 = 23.5 \pm 1\ M^{-2}$, and $\beta_3 = 15 \pm 10\ M^{-3}$ and, for the chloride system, $\beta_1 = 1.4 \pm 0.2\ M^{-1}$, $\beta_2 = 1.2\ M^{-2}$, and $\beta_3 = 0.1 \pm 0.1\ M^{-3}$. (auth)

12808 THE CRYSTAL STRUCTURE OF GADOLINIUM TRICHLORIDE HEXAHYDRATE. Massimo Marezio, H. A. Plettinger, and W. H. Zachariasen (Univ. of Chicago and Argonne National Lab., Ill.). Acta Cryst., 14: 234-6 (Mar. 10, 1961). (In English)

$GdCl_3 \cdot 6\ H_2O$ is monoclinic with space group P2/n and two molecules in the cell; a = 9.651, b = 6.525, c = 7.923 A; $\beta = 93.65°$. All atomic positions (except for hydrogen) were determined with high precision. The structure contains complexes $[Cl_2Gd(OH_2)_6]$ which are held together by O–H ... Cl bonds. Thus one third of the chlorine atoms are not bonded to gadolinium atoms. The only symmetry element of a complex is a twofold axis. The bond lengths are: Gd–Cl = 2.768, Gd–O = 2.39 – 2.42, O–H ... Cl = 3.14 – 3.24 A. (auth)

12809 ELECTRON IMPACT SPECTROSCOPY OF ETHYLENE OXIDE AND PROPYLENE OXIDE. Emilio J. Gallegos and Robert W. Kiser (Kansas State Univ., Manhattan). J. Am. Chem. Soc., 83: 773-7(Feb. 20, 1961).

Appearance potentials and relative abundances are reported for the principal positive ions in the mass spectra of ethylene oxide and propylene oxide, obtained by using a Bendix 12-100 time-of-flight mass spectrometer. Probable ionization and dissociation processes are given consistent with computed energetics, and the heats of formation of the various ions derived from the energetics are tabulated. Molecular ionization potentials were calculated by using the equivalent orbital method of Hall and were compared to the observed ionization potentials of 10.65 ± 0.1 ev for ethylene oxide and 9.80 ± 0.1 ev for propylene oxide. (auth)

12810 FREE RADICALS BY MASS SPECTROMETRY. XXI. THE IONIZATION POTENTIALS OF SOME META AND PARA SUBSTITUTED BENZYL RADICALS. A. G. Harrison, P. Kebarle, and F. P. Lossing (National Research Council, Ottawa). J. Am. Chem. Soc., 83: 777-80 (Feb. 20, 1961).

The ionization potentials of a number of meta and para substituted benzyl radicals were determined by electron impact. The substituents, in order of decreasing ionization potential of the radical, were m-CN, m-NO_2, p-CN, m-F, p-Cl, p-F, p-i-Pr, and p-CH_3O. The results are in agreement with the known electron-releasing or electron-attracting powers of the substituents. Since the effect of the substituents on the stability of the radicals themselves is very small, the results permit a consideration of the stabilization of ions in the gas phase where solvation plays no role. (auth)

12811 KINETICS OF SOME ELECTRON TRANSFER REACTIONS OF COBALT(III). Allan Zwickel and Henry Taube (Univ. of Chicago). J. Am. Chem. Soc., 83: 793-6 (Feb. 20, 1961).

The rates of reaction of V^{2+}_{aq} with complexes RL [R = $Co^{3+}(NH_3)_5$; L = OH_2, NH_3, Cl^-] were studied in H_2O and in D_2O. The rate of reaction of Cr^{2+}_{aq} with RNH^{3+}_3 was studied in the two media. Rates, ligand, and isotope effects were compared with those found in reactions, the nature of whose activated complexes are more definitely understood. (auth)

12812 THE OXIDATION STATES OF ASTATINE IN AQUEOUS SOLUTION. Evan H. Appelman (Univ. of California, Berkeley). J. Am. Chem. Soc., 83: 805-7(Feb. 20, 1961).

The redox equilibria among the oxidation states of astatine were studied in acidic solution. Reversible couples were used, and equilibria were approached from both sides. The –1, 0, +1 (?), and +5 states were characterized, but no evidence was found for a +7 state. The following potential scheme was determined at pH 1: $At^- \xrightarrow{-0.3} At(0) \xrightarrow{-1.0} HOAt(?) \xrightarrow{-1.5} AtO_3^- \xrightarrow{<-1.6} H_5AtO_6(?)$. It is shown that in the absence of I_2 the predominant At(0) species are neither At_2 nor the free radical (At·) but may well be compounds formed between astatine and organic impurities in the solutions. Whenever possible, I_2 was introduced to try to convert the At(0) to AtI. The photochemical oxidation of At(0) by VO^+_2 and by Fe^{3+} was investigated. (auth)

12813 ACID HYDROLYSIS OF $[PtCl_4]^=$ AND $[PtCl_3(H_2O)]^{-1}$. Charles I. Sanders and Don S. Martin, Jr. (Ames Lab., Ames, Iowa). J. Am. Chem. Soc., 83: 807-10(Feb. 20, 1961). (IS-136)

The equilibrium constant for the acid hydrolysis of $[PtCl_4]^{2-}$ at 25° is 3.0×10^{-2} at $\mu = 0$ and 1.5×10^{-2} at $\mu = 0.318$. The equilibrium constant for the acid hydrolysis of $[PtCl_3(H_2O)]^-$ at 25° is 1.0×10^{-3} at $\mu = 0$ and 5.4×10^{-4} at $\mu = 0.318$. A tentative value of 7.0 is reported for pK'_{11} where K'_{11} is the acid dissociation constant of $[PtCl_3(H_2O)]^-$. Tentative values are $pK'_{21} = 5.2$ and $pK'_{22} = 8.3$, where K'_{21} and K'_{22} are the first and second acid dissociation constants for $[PtCl_2(H_2O)_2]$. (auth)

12814 THE CHEMISTRY OF THE SOLVATED METAL CHELATES. IV. 8-QUINOLINOL CHELATES OF SCANDIUM(III), THORIUM(IV) AND URANIUM(VI). James H. Van Tassel, Wesley W. Wendlandt, and Edward Sturm (Texas Technological Coll., Lubbock). J. Am. Chem. Soc., 83: 810-12(Feb. 20, 1961).

The 8-quinolinol metal chelates of Sc(III), Th(IV), and U(VI) were studied by x-ray powder diagrams and nonaqueous titrations. X-ray data showed that the solvated chelates were triclinic in structure whereas the unsolvated chelates were of monoclinic symmetry. The nonaqueous titrations of the solvated metal chelates with potassium methoxide in acetonitrile showed that the scandium and thorium compounds behaved in a different manner than the uranium compound. It was not possible to prepare "mixed chelates," where the solvate molecule was different from the coordinated groups. (auth)

12815 THE EXCHANGE OF IRON BETWEEN THE AQUO FERROUS AND FERRIC VERSENATE IONS. W. L. Reynolds, Nora Liu, and J. Mickus (Univ. of Minnesota, Minneapolis). J. Am. Chem. Soc., 83: 1078-82(Mar. 5, 1961).

Electron transfer in the ferrous Versenate-ferric Versenate exchange reaction occurs chiefly between the Versenate complexes of Fe(II) and Fe(III) and not between any dissociation products of these complexes at pH 2. The electron transfer between the undissociated Versenate complexes of Fe(II) and Fe(III) probably occurs by tunneling. The exchange of Fe^{59} between $Fe^{2+}(aq)$ and FeY^- was found to be slow, and this exchange was compared with other electron-transfer reactions involving $Fe^{2+}(aq)$ and ionic oxidants on the basis of Marcus' theory of electron-transfer reactions. (auth)

12816 LANTHANUM AND NEODYMIUM SALTS OF TRIFLUORACETIC ACID. John E. Roberts (Univ. of Massachusetts, Amherst). J. Am. Chem. Soc., 83: 1087-8(Mar. 5, 1961).

Lanthanum and neodymium trifluoroacetates were prepared and characterized by analysis, crystallography, density, and solubility. When heated, these compounds decompose to form quantitative yields of metal fluoride, carbon monoxide, carbon dioxide, and trifluoroacetyl fluoride. (auth)

12817 SPIN-SPIN COUPLING CONSTANTS BETWEEN NON-BONDED C^{13} AND PROTONS IN SOME C^{13}-LABELED COMPOUNDS. Gerasimos J. Karabatsos (Michigan State Univ., East Lansing). J. Am. Chem. Soc., 83: 1230-2 (Mar. 5, 1961).

Spin-spin coupling constants between C^{13} and protons separated by one, two, or three bonds were measured in twelve compounds possessing either the isopropyl or the t-butyl group and labeled with C^{13} at specific carbon atoms. In diisopropyl ketone-carbonyl-C^{13}, isobutyric acid-carbonyl-C^{13}, and methyl isobutyrate-carbonyl-C^{13} the C^{13}-proton coupling constants do not decrease monotonically with the number of bonds separating the two nuclei: $J_{C^{13}-C-H}$ corresponds to 80% $J_{C^{13}-C-C-H}$ in the ketone and 97% in the acid and ester; $J_{C^{13}-C-C-H}$ is found to vary over a range of 53% (5.8 cps in methyl isobutyrate-carbonyl-C^{13} to 3.8 cps in isobutyl alcohol-1-C^{13}). In compounds possessing the isopropyl group $J_{C^{13}-C-C-H}$ has values in the range of 70–80% of the corresponding $J_{H-C-C-H}$; the two constants undergo changes which are, qualitatively, directly proportional to each other. The smallest spin-spin coupling constant between C^{13} and proton was found to be (3.5 cps) in the system $C^{13}-O-C-H$ of the methyl esters. (auth)

12818 A TRIHYDRIDO COMPLEX OF IRIDIUM(III). R. G. Hayter (Mellon Inst., Pittsburgh). J. Am. Chem. Soc., 83: 1259(Mar. 5, 1961).

The preparation and properties of a trihydrido complex of Ir(III), trihydridotris-(triphenylphosphine)-Ir(III), is discussed. This compound is the first reported example of a transition metal trihydride stabilized by tertiary phosphine ligands. (N.W.R.)

12819 COMPLEX CARBONYL HYDRIDES OF OSMIUM AND RUTHENIUM. L. Vaska and John W. DiLuzio (Mellon Inst., Pittsburgh). J. Am. Chem. Soc., 83: 1262-3(Mar. 5, 1961).

Preparations, along with characteristic properties, of the complex carbonyl hydrides of osmium and ruthenium are discussed. The metal-hydrido complexes were formed by using radiocarbon and deuterated alcohols as solvents. Results indicate than monohalogeno complexes of osmium and ruthenium contain also hydrido and carbonyl groups. (N.W.R.)

12820 ACTINIUM: RADIOCOLLOIDAL BEHAVIOUR. C. Lakshman Rao and A. R. Gupta (Atomic Energy Establishment, Trombay, India). J. Chromatog., 5: 147-52(Feb. 1961). (In English)

A report is given of the radiocolloidal behavior of actinium as studied by adsorption on sintered glass and on paper. (auth)

12821 PREPARATION OF N,N-DIFLUOROMETHYLAMINE AND N,N-DIFLUOROETHYLAMINE. J. W. Frazer (Univ. of California, Levermore). J. Inorg. Nuclear Chem., 16: 63-6(1960). (UCRL-5922)

A method is described for the preparation of N,N-difluoromethylamine and N,N-difluoroethylamine. Some of the physical properties of these compounds are listed. (auth)

12822 INFLUENCE OF CRYSTAL DIMENSIONS ON THE OXIDATION KINETICS OF UO_2. Bella Belbeoch, Claudia Piekarski, and Pierre Perio (Centre d'Etudes Nucléaires, Saclay, France). J. Nuclear Materials, 3: 60-6 (Jan. 1961). (In French)

The mechanism of oxidation of uranium dioxide at low temperatures was investigated with consideration of the specific surface area of the powder. The nature and properties of the tetragonal phases with O/U ratios between 2.3 and 2.4 were studied. The results are in reasonable agreement with a discontinuous diffusion mechanism previously proposed. (auth)

12823 NUCLEAR MAGNETIC RESONANCE STUDIES OF HYDROGEN BONDING. II. ALCOHOLS. Jeff C. Davis, Jr., Kenneth P. Pitzer, and C. N. R. Rao (Univ. of California, Berkeley). J. Phys. Chem., 64: 1744-7(1960). (UCRL-9268)

The proton magnetic resonance spectra of solutions of methanol, ethanol, 2-propanol, and t-butyl alcohol in carbon tetrachloride and of ethanol in benzene were measured over the temperature range of 20 to 60°. The shifts δ in very dilute solutions yielded values of δ_M for the monomeric alcohols. Finite values of $(\partial\delta/\partial x)$ at zero mole fraction were obtained which clearly indicated the presence of a dimeric species. The relationships between these data and the equilibrium constants and enthalpies of dimerization are discussed, but the probable presence of both cyclic and open dimers complicates the interpretation. For ethanol in benzene, where open dimers are believed to predominate, the enthalpy of dimerization was found to be 5.1 ± 1 kcal/mole of dimer. Only qualitative comments are made concerning the results in concentrated solution where many polymeric species are present. (auth)

12824 KINETICS AND MECHANISM FOR THE ELECTROCHEMICAL REDUCTION OF BENZOPHENONE IN ACIDIC MEDIA. Makoto Suzuki and Philip J. Elving (Univ. of Michigan, Ann Arbor). J. Phys. Chem., 65: 391-8(Mar. 1961).

The kinetic and mechanism factors in the electrochemical reduction of ketones were investigated by observation of the following relations for the reduction of benzophenone and p-bromobenzophenone over the pH range of 2 to 7: variation of $E_{1/2}$ with pH, ethanol concentration, and drop-time; variation of current with time at various points on the polarographic waves; and variation of the heterogeneous rate constant with pH, ethanol concentration, and temperature. The pinacol produced by dimerization of the free radical formed in the first one-electron wave may form an insoluble (adsorbed?) film at the interface which has marked effects on the observed behavior. The wave I electron-transfer process is quite rapid, but the subsequent irreversible chemical process (dimerization) causes the net reaction to appear irreversible. The process producing the second one-electron wave (reduction of free radical to carbinol) is quasi-reversible. The combined wave, observed above ~ pH 5, is controlled at first by the wave II process; with increasing pH, control shifts to the wave I process. The cause of the heretofore unobserved slight pH-dependency of wave II is discussed. (auth)

12825 AN INFRARED AND ISOPIESTIC INVESTIGATION OF THE INTERACTION BETWEEN TRI-n-BUTYL PHOSPHATE AND MONO-(2-ETHYLHEXYL)-PHOSPHORIC ACID. J. R. Ferraro and D. F. Peppard (Argonne National Lab., Ill.). J. Phys. Chem., 65: 539-41(Mar. 1961).

The interaction between tri-n-butyl phosphate and mono-(2-ethylhexyl)-phosphoric acid was investigated. The method of continuous variations utilizing changes in infra-

red absorption and changes in the freezing point depression of the mixtures was used. Isopiestic measurements also were made. Results gave evidence that an association product had resulted at a ratio of 2 moles of TBP per hexamer unit of H_2MEHP. (auth)

12826 HEAT CAPACITY AND THERMODYNAMIC PROPERTIES OF TITANIUM TETRAFLUORIDE FROM 6 TO 304°K. Robert D. Euler and Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor). J. Phys. Chem., 65: 132-4(1961).

The low-temperature heat capacity of titanium tetrafluoride was determined by adiabatic calorimetry and found to be without thermal anomalies. The thermodynamic properties were computed by numerical quadrature from the data. The values of the thermodynamic functions at 298.15°K are: $C_p = 27.31$ cal/(deg mole), $S^0 = 32.02$ cal/(deg mole), $H^0 - H_0^0 = 4841$ cal/mole, and $(F^0 - H_0^0)/T = -15.78$ cal/(deg mole). Comparison of the heat capacity of TiF_4 with other tetrafluorides supports the view that its crystal structure is intermediate between the molecular carbon tetrafluoride type and the coördinative zirconium tetrafluoride type. (auth)

12827 THE HOMOGENEOUS BASE-CATALYZED DECOMPOSITION OF HYDROGEN PEROXIDE. Frederick R. Duke and Trice W. Haas (Ames Lab., Ames, Iowa). J. Phys. Chem., 65: 304-6(1961). (IS-153)

The decomposition of hydrogen peroxide in alkaline aqueous solution was found to be homogeneous in polyethylene vessels when the reactants were sufficiently pure. The rate equation found is rate = $k_1 [H_2O_2] [HO_2^-]$ over a wide range of concentrations of reactants. (auth)

12828 THE INTERACTION OF GASES WITH CARBON SURFACES. R. V. Culver and H. Watts (South Australian Inst. of Tech., Adelaide). Rev. Pure and Appl. Chem. (Australia), 10: 95-138(June 1960). (In English)

The interactions between gases and carbon surfaces by chemisorption, reaction, and physical adsorption processes are reviewed. The crystal structure of graphite and of the amorphous carbons and the transitions in structure that occur during carbonization and graphitization processes were investigated. Chemisorption studies were made on amorphous carbons. Physical adsorption on heat-treated carbon blacks was also investigated. For the purpose of correlating adsorptive characteristics with the chemical composition of the surface, adsorption studies were made with carbon blacks and charcoals modified by heat-treatment in the absence of air and by oxidation, reduction, and steaming. The effect of alkali metals and other inorganic modifiers on the adsorptive capacity of charcoal was also examined. The effects of activation and sintering on the structure and physical properties of charcoals and carbon blacks were investigated. Structural modifications of graphites by gas adsorption and intercalation were studied. (M.C.G.)

12829 COMPARATIVE CHEMISTRY OF THE LANTHANIDE AND ACTINIDE ELEMENTS. B. B. Cunningham (Univ. of California, Berkeley). p.64-81 of "XVIIth International Congress of Pure and Applied Chemistry." London, Butterworths. (UCRL-8764)

A comparison was made of the properties of the lanthanide and actinide elements. The electronic configuration, oxidation-reduction behavior, thermodynamic properties, physical properties, spectroscopic and magnetic properties, and bonding factors were studied. The most obvious difference between the lanthanide and actinide elements was the greater variety of stable oxidation states of the latter. The reasons for this are discussed. (M.C.G.)

12830 PREPARATION OF BERYLLIUM OXIDE OF HIGH PURITY. R. Cooperstein and G. R. Anderson. U. S. Patent 2,974,012. Mar. 7, 1961.

A process is given for the preparation of beryllium oxide of high purity. A beryllium compound selected from the group consisting of beryllium oxide, beryllium hydroxide, beryllium sulfate, beryllium carbonate, and beryllium nitrate is reacted with molten oxalic acid to produce beryllium oxalate from the associated impurities, filtering said leach solution to separate it from unreacted beryllium compound and the more insoluble oxalates, cooling the leach solution to crystallize the beryllium oxalate, recovering the beryllium oxalate by filtration, and subsequently converting the beryllium oxalate to beryllium oxide by pyrolysis.

12831 PROCESSING OF CESIUM METAL CYANIDES. O. H. Koski. U. S. Patent 2,976,121. Mar. 21, 1961.

A process is given for converting a cesium double-metal cyanide, such as cesium zinc ferrocyanide, to the oxide. This is accomplished by heating a mixture of the double cyanide and cupric, zinc, aluminum, mercuric, ferric, and/or lead oxides in the presence of oxygen to between 150 and 360°C, leaching the product with water, and separating the cesium–hydroxide–containing leach solution from the insolubles.

Analytical Procedures

12832 (AE-37) SPECTROPHOTOMETRIC DETERMINATION OF THORIUM IN LOW GRADE MINERALS AND ORES. A.-L. Arnfelt and I. Edmundsson (Aktiebolaget Atomenergi, Stockholm). Aug. 1960. 14p.

A method for the determination of microgram quantities of thorium in samples of minerals and ores is described. The mineral sample is decomposed by repeated sintering with sodium peroxide. After digestion with water, thorium peroxide hydrate is recovered by centrifugation and dissolved in hydrochloric acid. Thorium is determined spectrophotometrically with naphtharson after its separation from metals forming chloro complexes that are adsorbed on a strongly basic anion exchange resin. Interferences from a few different ions were studied. The time required for the analysis of one sample is about 4 hr, if 12 samples are analyzed simultaneously. (auth)

12833 (AFSWC-TN-61-8) THE ANALYSIS OF URINE SPECIMENS FOR URANIUM AND PLUTONIUM. J. L. Howarth and R. O. Mills (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov. 1, 1960. Contract AF29(601)-1894. 27p.

Methods for analysis of urine for plutonium and uranium were studied for the purpose of recommending the most suitable methods. The sensitivity limits set were 10 dpm/liter of urine for plutonium and U^{235} and 10 μg/liter of urine for natural uranium. Liquid scintillation counting techniques were found unsatisfactory, and electrodeposition-autoradiography techniques, although providing much more than the required sensitivity, are unnecessarily complex. Alpha proportional counting in a flow counter is recommended. The recommended extraction procedures are the bismuth phosphate-lanthanum fluoride coprecipitation technique for plutonium and either the di-n-butyl orthophosphoric acid (DBP) extraction procedure or an anion exchange procedure for uranium. (auth)

12834 (CEA-1675) ADAPTATION DE L'AUTORADIOGRAPHIE A BASSE TEMPERATURE A LA DETECTION DU TRITIUM PAR ELIMINATION D'UNE LUMI-

NESCENCE PARASITE. (Adaptation of Low-Temperature Autoradiography to Tritium Detection by Elimination of Interfering Luminescence). P. Pellerin, P. Fallot, Laine-Boszormenyi, and F. Serrel (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucleaires, Saclay). 1960. 14p.

Low-temperature autoradiography was applied to the study of the diffusion of tritiated water in the animal organism. In the course of the work some striking disagreements were observed between the measured radioactivity of water in the organs and the relative intensity of blackening of the photographic plate on which they are projected. The cause of these paradoxical images was found in a phenomenon of luminescence, induced by the very soft β. The application of the low-temperature autoradiography technique to the detection of H^3 β rays therefore involves the use of filters opaque to ultraviolet and visible light, but permits the autoradiographic recording of radioactivity. (auth)

12835 (CEA-1701) DOSAGE SIMULTANE DU CESIUM 137 ET DES STRONTIUM 89 ET 90 DANS LES EAUX NATURELLES. (Simultaneous Determination of the Cesium-137 and the Strontium-89 and -90 in Natural Waters). J. Scheidhauer and L. Messainguiral (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1960. 12p.

A concentration and an unselective elution are effected by an exchange resin. The cesium is absorbed on ammonium molybdiphosphate precipitated with hydrofluoric acid after radium elimination. The strontium is stripped in concentrated nitric acid, precipitated in the form of strontium carbonate, and then counted near the radioactive balance. The yttrium is separated by thenoyltrifluoracetone and counted on a counting device. (auth)

12836 (HW-66219) SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN NUCLEAR GRADE GRAPHITE. Roy Ko (General Electric Co. Hanford Atomic Products Operations, Richland, Wash.). July 26, 1960. 10p. Contract AT(45-1)-1350.

The fluoride evolution method was adapted to the spectrographic determination of impurities in graphite. Impurities of B, Ca, Fe, Si, Ti, and V were determined by d-c arc excitation of sample–copper fluoride mixtures with an estimated precision of ±56%. Analyzing the sample directly without ashing permitted the determination of 0.5 to 10 ppm of these elements except calcium. The calcium lower limit was 50 ppm. Ashing 1 g of sample and analyzing the residue extended the limits to 0.02 ppm for boron and to 1 ppm for the others. Copper was used as the internal standard. (W.L.H.)

12837 (KAPL-M-CWK-2) DETERMINATION OF FREE GRAPHITE IN BORON CARBIDE BY X-RAY ANALYSIS. C. W. Krystyniak (Knolls Atomic Power Lab., Schenectady, N. Y.). July 11, 1960. Contract W-31-109-eng-52. 10p.

A direct method of determining the amount of free graphite in boron carbide by x-ray analysis was developed. The minimum detectable amount of graphite is ~3/4% with a precision of 1/4%. (D.L.C.)

12838 (NAA-SR-Memo-1045) ACTIVATION ANALYSIS OF COMMERCIAL GRADE TOLUENE. A. A. Jarrett and J. K. Taylor (North American Aviation, Inc., Downey, Calif.). July 6, 1954. 9p.

Commercial toluene, supposedly pure, was irradiated and the decays of the induced activities followed with scintillation and Geiger counters. The initial activity immediately after irradiation was 1740 and 1230 d/min/cc for the scintillation and Geiger counters, respectively. In the analysis of the decay curves, three probable isotopes were chosen from the comparison of possible impurities with the decay curves: Cl^{38}, Mn^{56} or Ni^{65}, and Mg^{27}. The following impurity concentrations were estimated: 600 to 620 ppm nickel, 60 to 95 ppm chlorine, 270 to 220 ppm magnesium, and 1.2 to 1.3 ppm manganese. The magnesium probably came from the irradiation capsule. (D.L.C.)

12839 (NAA-SR-Memo-1327) ACTIVATION ANALYSIS OF TERPHENYLS. J. K. Taylor (North American Aviation, Inc., Downey, Calif.). Apr. 1, 1955. 6p.

Chemically pure and commercial (Santowax brand) terphenyls were irradiated and the decays of the induced activities measured. The impurity concentrations were estimated from the decay data. (D.L.C.)

12840 (NAA-SR-Memo-2061) THE DETERMINATION OF OXYGEN IN SODIUM—A CRITICAL REVIEW OF ANALYTICAL METHODS. C. R. F. Smith (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [nd]. 56p.

Seven methods of measuring the sodium monoxide content of liquid sodium are reviewed. Data relating to the solubility of sodium monoxide in sodium are collected. Methods and data are criticized from the standpoint of precision and systemic interferences. It is concluded that there is no proved method which is free from systemic interferences and which is capable of measuring oxygen in sodium in quantities of 400 ppm or less. It is recommended that a program be undertaken to make comparative tests of all analytical methods and to determine the solubility of Na_2O in Na from 10 to 2000 ppm oxygen. (auth)

12841 (NP-9725) SPECTROGRAPHIC DETERMINATION OF TRACE AMOUNTS OF RARE EARTHS. Z. Radwan, B. Strzyzewska, and J. Minczewski (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). Oct. 1960. 23p. (PAN-180/VIII)

A new simplified method for the determination of trace amounts of rare earths in HCl and EDTA-Na solutions was developed. The solutions of rare earths lanthanum and yttrium and of the internal standard (palladium chloride) were evaporated on graphite powder and the sample was mixed with NH_4NO_3. Vertically arranged copper electrodes were used: the sifter electrode as the cathode and a flat-surfaced copper rod as the anode. The excitation source was a generator that combined a d-c arc with a Feussner spark. The excitation was effected in an atmosphere of 20% argon and 80% oxygen. The detection limit obtained for the two elements lanthanum and yttrium as chlorides and as versenates was 2.10^{-1} and 1.10^{-1} μg per sample, respectively. (auth)

12842 (NP-9732) SPECTROGRAPHIC ANALYSIS OF HALOGENS IN SOLUTION BY THE COPPER SPARK METHOD. Part I. J. Fijalkowski and A. Zelle (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). Sept. 1960. 20p. (PAN-176/XIII)

During spark excitation of solutions containing the halogen ions, many lines of fluorine, chlorine, bromine, and iodine appear in the spectrum. These lines are well suited for detecting traces as well as for quantitative determination of halogens. In the ultraviolet region, the sensitivity limits are for fluorine, 0.05%; chlorine, 0.01%; and bromine and iodine, 0.001%. For the determination of bromine and iodine ranging from 0.004 to 0.2%, the variation coefficient does not exceed ±10%. A controlled spark generator is used as the source of a light. The influence of various analytical conditions and the kind of excitation on the emission of the halogen lines were also investigated. (auth)

12843 (NRL-5519) K SERIES X-RAY EXCITATION EFFICIENCIES FOR BULK SPECIMENS. L. S. Birks (Naval Research Lab., Washington, D. C.). Sept. 19, 1960. 10p.

K series fluorescent x-ray emission was measured as a function of primary wavelength and intensity to give the excitation efficiency $E_{\lambda Z}$ for 14 elements from titanium to silver. Over-all standard deviations were estimated to be between 1 and 5%. Comparison with values calculated from early equations is in fairly good agreement but shows the measured values to be less than calculated values for low atomic numbers and higher for high atomic numbers. (auth)

12844 (PG-Report-162) ANALYTICAL METHOD FOR THE DETERMINATION OF TRITIUM IN URINE (LIQUID SCINTILLATION METHOD). (United Kingdom Atomic Energy Authority. Industrial Group. Windscale Works, Sellafield, Cumb., England). 1960. 6p.

The urine is decolorized with charcoal. The resulting water-clear liquid is mixed with a liquid scintillant, and the tritium content is measured with a coincidence counting system. The counting rate for tritium is evaluated by reference to an internal standard. (auth)

12845 (TID-6870(Pt.II)) ANALYTICAL PROCEDURES FOR THE DETERMINATION OF THORIUM AND RADIUM IN URANIUM PROCESS SAMPLES. Final Report—Part II. Henry Petrow, Robert J. Allen, Robert Lindstrom, and Bernard Sohn (Ionics, Inc., Cambridge, Mass.). Mar. 1, 1961. Contract AT(30-1)-2470. 25p.

A description of studies leading to the development of analytical procedures is presented for determining Th^{230}, Th^{234}, natural thorium, Ra^{223}, Ra^{224}, Ra^{226}, and Ra^{228}. Also included are analytical results obtained through application of the procedures to synthetic and mill samples and a discussion of factors affecting the procedures. (J.R.D.)

12846 (TID-6897) THE CHEMICAL DETERMINATION OF BORON IN BORON—CARBIDE—ZIRCONIUM. J. Rynasiewicz and V. F. Consalvo (Knolls Atomic Power Lab., Schenectady, N. Y.). [1958?] Contract W-31-109-eng-52. 20p.

A rapid dissolution, chemical method for the determination of boron and boron—carbide—zirconium is described. The sample is dissolved in a mixture of hydrofluoric plus hydrochloric acids contained in a platinum dish that is cooled in a dry-ice bed. Approximately 96 to 99% of the total boron remains undissolved. This is filtered off, ashed, and fused with sodium carbonate; the boron is determined with the classical mannitol titration method. The acid-soluble boron is determined by a modified mannitol titration after separating the zirconium and other interfering cations with barium carbonate. The acid-insoluble and acid-soluble boron are added to give the total boron in the sample. The accuracy and precision of this analysis were checked on synthetic mixtures of "standard" boron carbide plus zirconium. At the 2% boron carbide (1.59% B) level or higher, the method was accurate to at least 1.15 relative per cent. The precision (95% confidence level) was ±0.27 and ±0.95 relative per cent based on 8 measurements and a single measurement, respectively. "Standardization" of the boron carbide sample was performed by analyzing for boron, carbon, and impurities. A mass balance of 100.22 ± 0.69% was obtained. The boron value was considered accurate within the precision of the analytical method. (auth)

12847 (HW-tr-19) EXTRACTION AND DETERMINATION OF HYDROGEN IN URANIUM AND ZIRCONIUM. L. Champeix et al. Translated by Liz Appleby from Mém. sci. rev. mét., 57: 502-12(July 1960). Oct. 14, 1960. 18p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 18852.

12848 (UCRL-Trans-622(L)) FOCUSING ION-EXCHANGE. VII. QUANTITATIVE MICROANALYSIS OF HEAVY METALS AND RARE EARTHS. Ernst Schumacher and Hans Jakob Streiff. Helv. Chim. Acta, 41: 1771-83 (1958). Aug. 25, 1958. 15p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 1982.

12849 SPECTROPHOTOMETRIC DETERMINATION OF GERMANIUM IN BIOLOGICAL MATERIALS. George Rosenfeld (Univ. of California, Berkeley and Naval Medical Research Inst., Bethesda, Md.). Anal. Biochem., 1: 469-77 (Dec. 30, 1960). (In English)

A simple, reliable, and sensitive method for the determination of from 2 to 500 μg germanium in biological materials is presented. The germanium is distilled as $GeCl_4$ from a sample digested with nitric and sulfuric acids. The addition of ammonium molybdate and ferrous ammonium sulfate to the buffered distillate yields a blue color, the intensity of which is a linear function of the concentration from 2 to 50 μg. Amounts up to 500 μg can be determined with the use of a proper diluent. The effect of time, pH, reagent concentrations, and possible interfering substances on the colorimetric reaction is described. The analytical procedure was applied to studies of the normal occurrence of germanium in the rat and its distribution among various organs after parenteral administration. (auth)

12850 THE DETERMINATION OF ARSENIC AND ANTIMONY IN BIOLOGIC MATERIAL. Leo A. Dal Cortivo (Fordham Univ., New York), Michael Cefola, and Charles J. Umberger. Anal. Biochem., 1: 491-7(Dec. 30, 1960). (In English)

A method for the estimation of arsenic and antimony in biologic material is presented. It involves the evolution of arsine and stibine into a pyridine solution of silver diethyldithiocarbamate. The resulting colors are read spectrophotometrically. A new absorbing column is described which increases sensitivity and facilitates cleaning. Results are tabulated showing the excellent sensitivity and precision attained with the technique. Results of actual cases are also presented. (auth)

12851 THE ACCURATE DETERMINATION OF COBALT. II. GRAVIMETRIC METHODS AND IN PARTICULAR THE PHOSPHATE METHOD. A. G. Foster and W. J. Williams (Univ. of London, Eng.). Anal. Chim. Acta, 24: 20-32(Jan. 1961). (In English)

Some gravimetric methods for determining cobalt were examined to assess their value for the accurate determination of the metal. The electrolytic method was found to give high results (about 1.4%), and the anthranilate method, slightly high results (0.2 to 0.3%). A modification of the phosphate method was developed in which a former drawback, the solubility of $CoNH_4PO_4 \cdot H_2O$, was overcome by using a rapid spectrophotometric determination of residual cobalt. The final procedure developed was found to give accurate results (±0.1 to 0.2%), and its use is recommended where this degree of accuracy is required. (auth)

12852 GRAVIMETRIC DETERMINATION OF MOLYBDENUM AND ITS SEPARATION FROM OTHER METALS WITH N-BENZOYLPHENYLHYDROXYLAMINE. S. K. Shinha and S. C. Shome (Presidency Coll., Calcutta). Anal. Chim. Acta, 24: 33-6(Jan. 1961). (In English)

N-Benzoylphenylhydroxylamine was employed as a precipitant for the determination of Mo(VI). The precipitate

can be weighed either directly or as molybdenum trioxide after ignition. Molybdenum can be determined in the presence of appreciable amounts of Fe(III), Co(II), Cu(II), Cr(VI), and V(V). (auth)

12853 GRAVIMETRIC DETERMINATION OF BERYLLIUM WITH N-BENZOYLPHENYLHYDROXYLAMINE. J. Das and S. C. Shome (Presidency Coll., Calcutta). Anal. Chim. Acta, 24: 37-40(Jan. 1961). (In English)

N-Benzoylphenylhydroxylamine was employed in the gravimetric determination of beryllium and in its separation from iron, aluminum, and titanium. After suitable adjustment of pH, iron, aluminum, or titanium was precipitated quantitatively with the reagent; beryllium was subsequently precipitated after the pH of the filtrate was raised. The metal may be determined by either igniting the precipitate to beryllium oxide or weighing it as $Be(C_{13}H_{10}O_2N)_2$. (auth)

12854 MICRODETERMINATION OF COBALT IN REACTOR GRADE ZIRCONIUM. MICRODOSAGE OF COBALT IN THE "ZIRCONIUM REACTOR-GRADE." J. Vogel, D. Monnier, and W. Haerdi (Université, Geneva). Anal. Chim. Acta, 24: 55-60(Jan. 1961). (In French).

A method is described for the separation and determination of cobalt in 100-mg reactor-grade zirconium. Separation was effected by means of an ion-exchange resin. After elution, the cobalt was purified by extraction with dithizone and determined spectrophotometrically with the help of nitroso-R-salt. With this method a content of 0.0003% can be determined with an accuracy of ±4%. (auth)

12855 CALORIMETRIC DETERMINATION OF STRONTIUM. R. Paloušš, A. Kharnauchoff, and S. Mizera (Charles Univ., Prague). Anal. Chim. Acta, 24: 96-7(Jan. 1961). (In German)

A method for the colorimetric determination of strontium with dilituric acid (5-nitrobarbituric acid) is described. Tests were run using concentrations of 0.0 to 2.0 mg of strontium per milliliter. The maximum observed error was +0.02 mg of strontium per milliliter, and the average error was 0.006 mg of strontium per milliliter. (M.C.G.)

12856 KINETICS OF DECOMPOSITION OF YTTRIUM, CEROUS AND ZIRCONYL OXALATES. R. P. Agarwala and M. C. Naik (Atomic Energy Establishment, Trombay, India). Anal. Chim. Acta, 24: 128-33(Feb. 1961). (In English)

The kinetics of the decomposition of yttrium, cerous, and zirconyl oxalates were studied thermogravimetrically and also by differential thermal analysis. (auth)

12857 ANION EXCHANGE STUDIES OF ZIRCONIUM(IV) IN CITRATE SOLUTION. SEPARATION FROM MIXTURES. Shripad M. Khopkar and Anil K. De (Jadavpur Univ., Calcutta). Anal. Chim. Acta, 24: 134-7(Feb. 1961). (In English)

The anion exchange behavior of zirconium(IV) in a citrate system is described. Nitric acid, hydrochloric acid, perchloric acid, and ammonium chloride were tested as eluants on Dowex 21K column. Zirconium was separated from fission product elements, e.g., barium, strontium, cadmium, cesium, molybdate, and lead. (auth)

12858 THE APPLICATION OF CHELATE SYSTEMS TO PARTITION CHROMATOGRAPHY: PRELIMINARY PAPER. T. B. Pierce (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Anal. Chim. Acta, 24: 146-52(Feb. 1961). (In English)

It was found possible to retain solutions of chelating agents on a solid supporting medium. Preliminary investigations are reported which were carried out to determine the extraction behavior of radioactive copper between an aqueous hydrochloric acid phase and a solution of dithizone in an organic solvent retained on silica gel. Chloroform was found to be a very satisfactory solvent and carbon tetrachloride was also used. For both of these solvents the extraction vs. acidity curves were found to be similar to the corresponding liquid–liquid extraction. The high values for the fraction extracted show that this method would provide a useful technique for the concentration of copper from aqueous solution, and the similarity between the liquid–liquid and liquid–solid extractions suggests that it may be possible to adapt conventional liquid–liquid extractions to work on the column principle. (auth)

12859 COLORIMETRIC DETERMINATION OF URANIUM(VI). Gh. Baiulescu and I. C. Ciurea (C. I. Parhon Univ., Bucharest). Anal. Chim. Acta, 24: 152-4(Feb. 1961). (In English)

A very sensitive reagent is proposed for the colorimetric determination of uranium(VI), namely 1-phenyl-3-methyl-4-(3′-carboxy-4′-hydroxyphenyl-azo)-pyrazol-5-one. (auth)

12860 UTILISATION OF PHENYLARSONIC ACID IN TURBIDIMETRY. DETERMINATION OF TANTALUM. R. Saint-James and T. Lecomte (Centre d'Études Nucléaires, Saclay, France). Anal. Chim. Acta, 24: 155-60(Feb. 1961). (In French)

A turbidimetric method is described for the determination of tantalum with phenyl arsonic acid. The method is fast and rarely requires preliminary separation. The only interfering elements are zirconium and niobium when present in molar ratios greater than Nb : Ta = 1 and Zr : Ta = 5. (auth)

12861 THE SPECTROPHOTOMETRIC DETERMINATION OF MICROGRAM AMOUNTS OF CERIUM. F. Culkin and J. P. Riley (Univ. of Liverpool). Anal. Chim. Acta, 24: 167-70(Feb. 1961). (In English)

A spectrophotometric procedure, which has a coefficient of variation of ~ 2%, is described for the determination of up to 80 μg of cerium. Ceric ion formed by oxidation with persulfate in the presence of catalytic amounts of silver is reduced to the cerous state by treatment with excess ferrous–phenanthroline reagent. The decrease in optical density of the ferrous–phenanthroline compared with the reagent blank is a measure of the amount of cerium present. The only common cations which cause serious interference are Mn^{+2} and Cr^{+3}. (auth)

12862 CHROMATOGRAPHIC SEPARATION AND RADIOMETRIC ANALYSIS OF C^{14}-LABELLED SUBSTANCES HAVING A HIGH BOILING POINT. Fulvio Cacace, Angelo Guarino, and Inam-ul-haq (Università, Rome and CNR, Rome). Ann. chim. (Rome), 50: 917-19(1960). (In Italian) (CNEN-19)

A technique for the simultaneous chromotographic and radiometric analysis of substances containing radiocarbon and having a high boiling point is described. This method is based on the continuous combustion of radioactive compounds flowing from the column together with water and CO_2, the latter then comes to the thermoconductive cell of the chromatograph and to a flux ionization chamber. Measurement is made of the concentration and activity of separated compounds. (auth)

12863 ON THE POSSIBILITY OF QUANTITATIVE DETERMINATION OF CHROMOPROTEINS BY THE RADIOMETRIC METHOD. A. A. Shatalova, G. I. Meerov, and Ya. R. Savinskii (Bekhterev Scientific-Research Psychoneurological Inst., Leningrad). Biochemistry (U.S.S.R.) (English Translation), 25: 443-7(Jan.-Feb. 1961).

A radiometric method is described for the quantitative determination of hemoglobin in blood. The method is based

on the ability of chromoproteins to unite with C^{14} labeled carbon monoxide in equimolar ratios. Results of hemoglobin determinations made by the radiometric method compared favorably with results obtained by the photometric method. (C.H.)

12864 POLAROGRAPHIC ANALYSIS OF PROTEIN SOLUTIONS WHICH HAVE BEEN SUBJECTED TO WEAK IONIZING RADIATION. L. M. Buruiana and V. Pavlu (Faculty of Veterinary Medicine, Bucharest and Polytechnic Inst., Bucharest). Biochemistry (U.S.S.R.) (English Translation), 25: 455-9(Jan.-Feb. 1961).

Changes induced by weak ionizing radiation (Co^{60}) are specific for the proteins studied and are expressed in the reversible formation of macromolecular aggregates. Polarographically this is expressed as an increase in the capacity to suppress the cobalt maximum and as a change in the height and potential of the catalytic maxima. These changes are due to changes in mobility of protons of protonotropic groups and to the formation of macromolecular aggregates. (auth)

12865 SPECTROPHOTOMETRIC DETERMINATION OF TRACES OF BORON IN THORIUM. Hiroshi Onishi, Nasumi Ishiwatari, and Hitoshi Nagai (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 33: 1686-8(Dec. 1960). (In English)

A procedure is described for the spectrophotometric determination of a few tenths of a part per million of boron in thorium oxide or thorium. The sample is dissolved in strong phosphoric acid. After diluting the solution with water, boron is separated by distillation as methyl borate and finally determined by the curcumin method. The error is not likely to exceed ±0.1 ppm for 0.2 to 1 ppm of boron. (auth)

12866 SPECTROPHOTOMETRIC DETERMINATION OF COPPER IN URANIUM WITH 8-QUINOLINOL. Kenji Motojima, Hiroshi Hashitani, and Hideyo Yoshida (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 10: 79-82 (Feb. 1961). (In Japanese)

A new spectrophotometric method for copper in uranium, based on the extraction with chloroform as the 8-quinolinate was developed. Submilligram quantities of uranium and all other metals which are apt to accompany copper, can readily be eliminated by washing the extract with a sodium hydroxide solution (15%). A minor disadvantage is the rather narrow range of pH (3.1 to 3.3) that had to be maintained at the first extraction. The method is accurate and rapid for copper determination in uranium down to 0.5 ppm. (auth)

12867 PHOTOMETRIC DETERMINATION OF COPPER IN HIGH PURITY THORIUM COMPOUNDS. (DETERMINATION OF IMPURITIES IN THORIUM. I.). Tomoyuki Mukoyama and Norio Ichinose (Yamanashi Univ., [Japan]). Bunseki Kagaku, 10: 107-11(Feb. 1961). (In Japanese)

A method was studied for the photometric determination of copper (> ca. 0.2 ppm) in thorium oxides or nitrates of the reactor grade. A sample (1 to 2.5 g as ThO_2) is dissolved in 10 ml nitric acid (1 + 1) and 3 drops of hydrofluoric acid and evaporated to dryness. The residue is dissolved in 1 ml nitric acid (1 + 1) and several ml of water by gentle heating, and transferred to a 50 ml beaker. Five ml of 50% citric acid and 8 to 12 ml of ammonium hydroxide (1 + 1) are added with stirring. After the solution is transferred to a 100 ml separating funnel, 4 ml of 1% EDTA is added and the solution is diluted to about 40 ml. The pH should be about 9 against thymol blue paper. One ml of 0.2% sodium diethyldithiocarbamate is then added, and the solution is skaken with 5.00 ml of iso-amyl acetate for about 2 minutes. The extract is filtered through a small dry paper, and the absorbancy is measured at 430 mμ. A reagent blank is run through the whole procedure. The calibration curve is derived from an experimental curve plotted using the procedure and a standard series of copper solutions containing about the same amount of thorium compound. (auth)

12868 DETERMINATION OF TRACE AMOUNT OF LEAD IN URANIUM METAL BY A. C. POLAROGRAPHY AND SPECTROPHOTOMETRY. (DETERMINATION OF TRACE IMPURITIES IN URANIUM METAL. XIV.). Ken Saito and Tsugio Takeuchi (Nagoya Univ., [Japan]). Bunseki Kagaku, 10: 152-6(Feb. 1961). (In Japanese)

The uranium metal sample was dissolved in hydrochloric acid and hydrogen peroxide. For the extraction of trace amounts of lead from a large amount of uranium, dithizone-benzene solution was used. To mask trace impurities of Cu, Ni, Fe, and Zn, ammonium citrate, sodium sulfite, potassium cyanide, and ammonium hydroxide were added to the sample solution. The lead extracted into the dithizone-benzene solution was shaken with and transferred into 0.45N perchloric acid, and determined by the a-c polarography. In the case of spectrophotometric determination, the absorbency of the extracted dithizone-benzene solution was measured at 520 mμ. Good agreement was obtained between the results from the two methods. (auth)

12869 COLORIMETRIC DETERMINATION OF TRACE AMOUNTS OF IRON IN URANIUM BY THE COLOR DEVELOPMENT IN THE SOLVENT LAYER. (DETERMINATION OF TRACES OF IMPURITIES IN URANIUM METAL. XV.). Takayoshi Yoshimori (Gifu Univ., [Japan]), Yoshirô Tomida, and Tsugio Takeuchi. Bunseki Kagaku, 10: 156-60(Feb. 1961). (In Japanese)

A simplified procedure for the colorimetric determination of iron in metallic uranium was proposed. Iron in uranium chloride solution of 7.5N hydrochloric acid was extracted into butyl acetate, and the solvent layer was washed twice with 7.5N hydrochloric acid. The same volume of methyl-isobutyl-ketone was added to the solvent, and the mixed solvent layer was shaken with 20% aqueous solution of ammonium thiocyanate. The color developed in the solvent layer was measured, using a 520 mμ filter. One to 20γ of iron in 0.1 to 1g of uranium could be determined with satisfactory results. (auth)

12870 CHELOMETRIC TITRATIONS IN THE PRESENCE OF TUNGSTEN AND MOLYBDENUM. E. Lassner and R. Scharf (Metallwerk Plansee A.-G., Reutte, Tirol, Austria). Chemist Analyst, 50: No. 1, 6-7(Mar. 1961).

The masking of tungsten and molybdenum against EDTA by various reagents was considered. It was found that tungsten can be masked by the addition of tartrate, fluoride, orthophosphate, and hydrogen peroxide. Attempts at masking molybdenum in the same manner were unsuccessful. It was established that diaminocyclohexanetetraacetic acid (DCYTA) can serve as the titrant for a number of cations in the presence of large amounts of tungsten and molybdenum without the addition of a masking agent. (M.C.G.)

12871 SENSITIVE METHOD FOR DETECTION AND SEMIQUANTITATIVE DETERMINATION OF URANIUM. Z. Sulcek, J. Michal, and J. Dolezal (Charles Univ., Prague). Chemist Analyst, 50: No. 1, 13-14(Mar. 1961).

A method for the detection and semiquantitative estimation of uranium in inorganic materials was devised. The method is based on the intense fluorescence under ultraviolet light of uranyl ion adsorbed on a silica gel column.

The intensity of the fluorescence can be compared with standards similarly prepared. In a test of this method, the fluorescence was only followed to a dilution of 1.5×10^7; the dilution limit was not reached. The error of estimation was found to be < 40%. (M.C.G.)

12872 AUTOMATIC ANALYSIS IN NUCLEAR TECHNIQUES. P. Desneiges (Commissariat a l'Energie Atomique, Paris). Chim. anal., No. 3, 120-6(Mar. 1960) and Chim. anal., No. 4, 195-9(Apr. 1960). (CEA-1621). (In French)

Analytical devices for the quantitative estimation, often from some distance, of radioactive elements in solution are described. The concentrations of these radioelements are usually very low. The methods and apparatus are based on the selective detection of radiations present together in the solutions. This selective detection eliminates the often very intense parasitic radiations emitted by the solutions. The industrial analytical apparatus makes continuous estimations possible, and facilitates certain chemical operations. Some control instruments from the Marcoule plutonium extraction plant, and the industrial and continuous determination of uranium in solution are described. (auth)

12873 CHLORANILIC ACID AS A REAGENT IN THE PAPER CHROMATOGRAPHY OF INORGANIC COMPOUNDS. II. HEAVIER METALS. H. S. R. Barreto (Rural Univ., Rio de Janeiro), R. C. R. Barreto, and I. P. Pinto. J. Chromatog., 5: 5-8(Jan. 1961). (In English)

The use of chloranilic acid was studied as a reagent in the paper chromatography of some of the heavier metals. Sensitivity is found to vary from 0.01 μg for ferric iron to 5.0 μg for Hg(II) and zinc. It was found that iron gives tailing spots with most of the solvent systems, which interferes with the separation of the other cations. This interference was avoided by using acetone–acetic acid, which displaces iron to the solvent front. Efficient two-dimensional separations were obtained by carrying out a second run with ethanol–acetic acid. (auth)

12874 THE DETECTION OF TRITIUM LABELLED COMPOUNDS IN VAPOUR PHASE CHROMATOGRAPHY. Horace E. Dobbs (Wantage Radiation Lab., Berks, Eng.). J. Chromatog., 5: 32-7(Jan. 1961). (In English)

Several methods for measuring tritiated materials as they come off a vapor-phase chromatography column are developed. A brief review of scintillation and proportional methods and a more detailed account of a gas flow ionization chamber used at temperatures up to 190°C are given. (auth)

12875 LATERAL DIFFUSION AND LOCAL NONEQUILIBRIUM IN GAS CHROMATOGRAPHY. J. Calvin Giddings (Univ. of Utah, Salt Lake City). J. Chromatog., 5: 61-7 (Jan. 1961). (In English)

The occurrence of local nonequilibrium in gas chromatography is investigated. The question concerning whether liquid- or gas-phase lateral diffusion is the rate-controlling step is discussed in the light of theoretical equations. It is found that this depends greatly on the distribution of stationary liquid over the solid support. With allowance for both liquid and gas diffusion, and also for the influence of tortuous streamlines leading to eddy diffusion, a new approximate plate height equation is obtained. Finally, some of the important unsolved problems in the field of gas chromatography are discussed. (auth)

12876 DETERMINATION OF TRACES OF COPPER IN RUBBER LATEX ASH BY NEUTRON ACTIVATION ANALYSIS. J. A. W. Dalziel and R. C. H. Hsia (Imperial Coll. of Science and Tech., London). J. Sci. Food Agr., 12: 127-30(Feb. 1961).

Neutron activation is used to determine copper in latex ash. Purification of the copper activity by homogeneous sulfide precipitation in the presence of carriers is sufficient for the resolution of the 0.51-Mev γ activity of Cu^{64} by scintillation spectrometry. The further purification, particularly from P^{32}, which is needed for β counting is achieved by electrodeposition. Chemical yields are determined by EDTA titration. A typical ash was found to contain 370 ± 20 ppm copper. (auth)

12877 CHELATE FORMATION BETWEEN THORIUM ION AND SODIUM ALIZARIN-3–SULPHONATE: A SPECTROPHOTOMETRIC STUDY. Samir K. Banerji and Arun K. Dey (Univ. of Allahabad, India). J. Sci. Ind. Research (India), 20B: No. 2, 58-62(Feb. 1961). (In English)

The spectrophotometric method developed for studying the stability of a complex is employed for the study of chelate formation between thorium ion and sodium alizarin-3-sulfonate. The composition of the chelate is found to be $Th(ARS)_2$, by the method of continuous variation, using absorption-spectrum data, obtained with a Unicam SP 500 spectrophotometer. The chelate has a λ_{max} at 520 mμ and is stable between pH 2.85 and 8.0. The value of log K is found to be 8.23 ± 0.11, and $\Delta F°$ is −11.35 kcal at 25°. (auth)

12878 ANALYSES AND QUANTITATIVE DETERMINATION OF THE STRONTIUM RADIOISOTOPES 89 AND 90 IN MILK POWDER. Lucien Jeanmaire and Georges Michon (Commissariat a l'Energie Atomique, [Paris]). Lait, 39: 369-81(July-Aug. 1959). (CEA-1329). (In French)

A procedure is given for the determination of Sr^{89} and Sr^{90}. The concentration of strontium is made possible by the insolubility of its nitrate salt in strong nitric acid, which allows the removal of the greatest part of the calcium. The purification is performed on a cation exchange column. The amount of Sr^{90} is determined by means of its daughter product Y^{90} necessary calibrations and computations are given. With regard to the reproducibility of the measurements, the fluctuations are less than 20%. This seems satisfactory for a technique having great sensibility and requiring much time and great care. (auth)

12879 STUDIES ON THE MICRODETERMINATION OF METALS BY EXTRACTING THE INORGANIC COMPOUNDS WITH ORGANIC SOLVENTS. III. MICRODETERMINATION OF MOLYBDENUM. Hidehiro Gotô and Shigero Ikeda (Research Inst. for Iron, Steel and Other Metals, Japan). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 276-84 (Aug. 1959). (In English)

The molybdenum ion reduced by stannous chloride or hydrazine sulfate forms a complex compound with thiocyanate, which can be extracted by organic solvent from aqueous solution. The maximum absorption peaks of this compound were found at 335 and 468 mμ when stannous chloride was used as reducing agent and at 320 and 460 mμ when hydrazine sulfate was used. The absorbancies were proportional to the molybdenum content at these wavelengths and adoptable for the microdetermination of molybdenum. Organic solvents suitable for the extraction of molybdenum compound are acetate esters, alcohols, and mixed solvent of esters or alcohols with carbon tetrachloride or chloroform. Optimum acid concentrations for the extraction and spectrophotometric determination of molybdenum are 0.9 to 1.0N of hydrochloric acid in stannous chloride reduction and 0.8 to 1.2N of sulfuric acid in hydrazine sulfate reduction method. About 1 to 10 γ of molybdenum can be determined by this method. (auth)

12880 STUDIES ON ANALYTICAL METHODS FOR TRACE ELEMENTS IN METALS BY USING RADIOACTIVE

ISOTOPE. I. DETERMINATION OF ZIRCONIUM IN STEEL. Hiroshi Amano (Research Inst. for Iron, Steel and Other Metals, Japan). Sci. Repts. Research Inst., Tohoku Univ., Ser. A, 11: 296-303(Aug. 1959). (In English)

Using the radioisotope Zr^{95} as a tracer, experiments were carried out on the determination of zirconium by the phosphate, arsenate, basic selenite, and mandelate methods, and on the separation of zirconium from iron by means of mercury cathode electrolysis and ion exchange resin. From the experimental results, it is recommended that zirconium be precipitated as its phosphate after the separation from iron by means of mercury cathode electrolysis. (auth)

12881 STUDIES ON ANALYTICAL METHODS FOR TRACE ELEMENTS IN METALS BY USING RADIOACTIVE ISOTOPE. II. DETERMINATION OF NIOBIUM AND TANTALUM IN STEEL. Hiroshi Amano (Research Inst. for Iron, Steel and Other Metals, Japan). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 304-16(Aug. 1959). (In English)

The methods of determining and separating niobium and tantalum in steels were studied using the radioisotopes Nb^{95} and Ta^{182} as the tracer and radioactive indicator. It was seen that the perchloric acid hydrolysis separation method was most superior, and that after the single separation from iron, the sum of niobium and tantalum was successfully titrated with cupferron solution by using Ta^{182} as a radioactive indicator. (auth)

12882 STUDIES ON ANALYTICAL METHODS FOR TRACE ELEMENTS IN METALS BY USING RADIOACTIVE ISOTOPE. III. DETERMINATION OF TANTALUM BY MEANS OF ISOTOPE DILUTION METHOD. Hiroshi Amano (Research Inst. for Iron, Steel and Other Metals, [Japan]). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 360-6(Oct. 1959). (In English)

The determination of tantalum by the isotope dilution method in the presence of niobium was investigated by the use of the radioisotope Ta^{185}. Tantalum was separated from niobium as tantalum-tannin precipitate under the optimum conditions of a pH of 1.9 to 2.5 and a tantalum/niobium ratio of up to 1/50. If niobium was present in amounts 100 times or more that of tantalum, reprecipitation was needed. The reciprocal of the specific activity of tantalum pentoxide precipitate was in a linear relation to the change in the amount of tantalum added. The recommended method gave an accurate result in the determination of tantalum in steel. (auth)

12883 STUDIES ON ANALYTICAL METHODS FOR TRACE ELEMENTS IN METALS BY USING RADIOACTIVE ISOTOPE. IV. DETERMINATION OF ALUMINIUM WITH CALCIUM-45 TYPE CATION EXCHANGER. Hiroshi Amano (Research Inst. for Iron, Steel and Other Metals, [Japan]). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 367-74(Oct. 1959). (In English)

Aluminum was determined radiometrically by using Ca^{45} and cation exchange resin. The sample solution containing Al^{3+} was adjusted to a pH of 3.0 to 4.0 and was treated with the cation exchanger of Ca-R type labeled with Ca^{45}. The radioactivity of eluted calcium was exactly equivalent to the amount of aluminum ion present. Interferences of ferrous, magnesium, and ammonium ions were examined, and no serious effect was observed. This method was applied to the determination of aluminum in carbon steel, and the results obtained agreed with those by photometric method. (auth)

12884 STUDIES ON ANALYTICAL METHODS FOR TRACE ELEMENTS IN METALS BY USING RADIOACTIVE ISOTOPE. V. DETERMINATION OF HAFNIUM IN ZIRCONIUM BY MEANS OF ISOTOPE DILUTION METHOD. Hiroshi Amano (Research Inst. for Iron, Steel and Other Metals, [Japan]). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 383-92(Oct. 1959). (In English)

A method for the determination of hafnium in zirconium metal was studied. Hafnium was enriched from a hydrochloric acid solution of zirconium with four steps of thiocyanate-hexone extraction-stripping method. After the several steps of extraction, pure hafnium fraction was obtained by passing the solution through the cation exchanger resin column, and eluting with the mixture of 0.45M nitric acid and 0.095M citric acid as an eluant. Combining the isotope dilution method and the above-mentioned method, hafnium, which existed from 0.025 to 0.1% in zirconium, was determined. (auth)

12885 A NEW PHOTOMETRIC DETERMINATION OF CERIUM WITH METHYLENE BLUE. Hidehiro Gotô and Yachiyo Kakita (Research Inst. for Iron, Steel and Other Metals, [Japan]). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 442-50(Dec. 1959). (In English)

A photometric determination of cerium was examined by the utilization of the reaction between methylene blue and cerium(IV). Cerium(IV) reacts with methylene blue in a weakly alkaline solution of sodium hydroxide, and an extraction of this mixture with benzene gives a reddish violet coloration. Absorption maximum of this colored solution lies at 510 mμ, and the amount of cerium and absorbancy are in linear relationship. Optimum pH of the solution at the time of extraction is above 9.6. The effect of coexisting elements was examined and it was found that manganese alone exhibited a similar reaction, while tungsten, chromium, and antimony(V) affected this reaction. The majority of the other elements was found to have comparatively small effect. This reaction was applied to the determination of cerium in thorium oxalate and lanthanum oxalate, and the results obtained are shown. (auth)

12886 STUDIES ON ANALYTICAL METHODS FOR TRACE ELEMENTS IN METALS BY USING RADIOACTIVE ISOTOPES. VI. THE ANALYTICAL METHOD FOR RADIOACTIVE NUCLIDES CONTAMINATING THE SURFACE OF SEVERAL METALS. Hiroshi Amano (Research Inst. for Iron, Steel and Other Metals, [Japan]). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 458-65(Dec. 1959). (In English)

The analytical methods for determination of radioactive nuclides, which contaminated metallic surfaces, were studied. The test specimens were dipped into a nitrate solution of fission products which was adjusted to pH of 1.4. The radioactive nuclides were removed from the surfaces of specimens by means of anode electrolysis. Zr^{95}, Nb^{95}, and Y^{90} were coprecipitated with the metal hydroxide and separated as zirconium phosphate, niobic acid, and yttrium oxalate. Ru^{106} and Rh^{106} were precipitated as sulfides from the filtrate. Sr^{90} was determined as its oxalate and Cs^{137} as its perchlorate. From the experimental results it was supposed that the radioactive contamination with fission products from a solution of pH 1.4 occurred by the surface adsorption of radioactive nuclides. (auth)

12887 FLUORESCENT X-RAY EXCITATION EFFICIENCIES. L. S. Birks (U. S. Naval Research Lab., Washington, D. C.). Spectrochim. Acta., 17: 148-54(Mar. 1961).

K-series fluorescent x-ray emission was measured as a function of primary wavelength and intensity to give the excitation efficiency E_{λ_2} for fourteen elements from titanium to silver. Over-all standard deviations were estimated to be between 1 and 5%. Comparison with values calculated

from early equations is in fairly good agreement but shows the measured values to be less than calculated values for low atomic numbers and higher for high atomic numbers. (auth)

12888 RADIOMETRIC TITRATION OF ZINC AND COPPER WITH EDTA. I. Gălăteanu, I. Maxim, and T. Braun (Inst. of Atomic Physics, Bucharest). Z. anal. Chem., 172: 274-9(1960). (In English)

A titration procedure using radioactive indicators for detecting the equivalence point in complexometry was applied to the determination of copper and zinc. All titrations were run using EDTA and Ag^{110} precipitated as a nonisotopic detector in heterogeneous phase. Variation of pH values from 10 to 2 and then again to 10 did not affect the activity of the solution. (M.C.G.)

12889 COMPLEXOMETRIC METHOD FOR DETERMINING ZIRCONIUM WITH XYLENE ORANGE INDICATOR. A. E. Klygin and N. S. Kolyada. Zavodskaya Lab., 27: 23-4 (1961). (In Russian)

The use of xylene orange indicator for complexometric titrations of Zr with trilon presents several advantages although it yields low values. The indicator should be used in solutions containing from 0.1 to 0.6N H_2SO_4; the maximum optical density of the coloration is reached in a 0.25N solution. Amounts of Zr ranging from 1.5 to 20 mg could be determined with satisfactory accuracy even in the presence of 200 mg of hexavalent U and 5 mg of trivalent Fe. While the presence of many other ions can be tolerated, ions which form complexes with Zr such as PO_4^{3-}, $C_2O_4^{2-}$, F^-, or with the indicator, such as Bi^{3+}, interfere with the analysis. The determination can be completed within 15 to 20 minutes after dissolution of the material. (TTT)

12890 DETERMINATION OF THE WEIGHT CONCENTRATION OF DUST IN AIR BY MEANS OF β-RADIATION. G. A. Izmaĭlov (Central Automation Lab., USSR). Zavodskaya Lab., 27: 40-3(1961). (In Russian)

The current methods used for the direct determination of the dust content of air, based on the Tyndall effect of photoelectric devices, present serious drawbacks. Best reproducibility is obtained by using gravimetric dust collecting methods; special filters appear to be superior in this respect to cyclones or precipitators. In the method developed, a special filter material was used in view of its high collection coefficient, low weight per unit surface and low aerodynamic resistance to the flow of air. In order to eliminate the time-consuming weighing, the absorption of β radiation was used for the determination of the amount of dust collected while letting the air flow through the filter at a constant rate. A scintillation counter was used as detector; the derivative of the voltage as function of time or air volume served as a measure of the weight increase on the filter and so of the dust content of the air. Constructional details of the apparatus are given. (TTT)

12891 IONIZATION TYPE INDICATOR FOR METHANE USING TRITIUM RADIATION SOURCES. G. D. Gorlovoi. Zavodskaya Lab., 27: 108-11(1961). (In Russian)

The previously used α-active materials for determining the concentration of certain gases in air were insufficient because the protective film necessary to prevent contamination strongly absorbed the radiation or was so thin that it could not prevent diffusion. Materials emitting β-radiation showed more promise in this respect. Tritium was found quite satisfactory; it was employed in the form of absorbed material in Zr or Ti. Tritium presented the following advantages: long half-life, low cost, stability of the compound with the metal (similar to targets used for neutron generation), high specific activity, and a short free path in air. The device can thus be safely used under industrial conditions. The ionization current was measured with the help of a sensitive galvanometer. The absorption current presented a linear function of the methane content in the air. Such ionization chambers with tritium targets are useful for constructing devices for the determination of the methane concentration, heavy hydrocarbon content; the same principle may be employed for fire alarm instruments hygrometers, etc. (TTT)

12892 SPECTROGRAPHIC METHODS OF DETERMINING N^{15}. K. Starzynski. p.744 of "Pierwsze Krajowe Sympozjum Poswiecone Stosowaniu Isotopow Promieniotworczych W Biologii, Medycynie, I Rolnictwie, 2 i 3 Kwietnia 1959, Warszawa." Warsaw, Bureau of the Atomic Energy Ministry, 1959. (In Polish)

The use of N^{15} in connection with mass spectrometry of stable isotopes is finding successively wider application in biological investigations. This fact, along with the difficulty of getting measurements done with nearby spectrometers committed to other work, has led to the development of a spectrographic method of quantitative determinations of N^{15} in nitrogenous materials. The spectrograph ISP 22 was used to observe an emission spectrum of nitrogen excited in an intense 20-Mc rf field. The nitrogen of organic substances, prepared by the method of Kieldahal, oxidizes to molecular nitrogen. This gas fills capillary tubes of about 1 mm in diameter to where the rf field induces spectral emission. The spectrograph is able to resolve the 3159 A line of the N_2^{14} molecule and the N^{14}-N^{15} 3162 A line to such a degree that it is possible to collect the light from each of the lines separately by using photographic film. Exposure times from 2 sec to 20 min are adjusted to obtain equal blackening of the film. The required exposure times then determine the ratio of N_2^{14} to N^{14}-N^{15} molecules in the organic specimen, resulting in accuracies of 2 to 3%. Measurements can be made much faster than with mass spectrometers without using high-purity nitrogen. Furthermore, only about one-twentieth of the nitrogen is needed to make a determination. (TTT)

General Inorganic and Physical Chemistry

12893 (ARL-TN-60-130) THE STRUCTURE OF BORON OXIDE AND SIMPLE BORATES. J. D. Mackenzie (General Electric Co. Research Lab., Schenectady, N. Y.). Oct. 1960. Contract AF33(616)-5699. 36p.

A broad program of research has been conducted to obtain structural information on the vitreous and liquid B_2O_3 and binary borates. By use of high-pressure techniques, simple crystals of two forms of B_2O_3 were prepared for x-ray-diffraction studies. The tentative phase diagram for liquid and crystalline B_2O_3 was constructed up to 1100°C and 90,000 atm. B_2O_3 was examined, and some of the current hypotheses concerning the structure of liquid B_2O_3 can be rejected. Preliminary results on the infrared absorption of solid and liquid B_2O_3 are presented. A description is given of other work in progress which includes nuclear-magnetic-resonance absorption, viscosity measurements of binary borates at temperatures below the liquidus, single-crystal diffraction on α- and β-B_2O_3 and high-pressure flow measurements on liquid B_2O_3. (auth)

12894 (ARL-TN-60-176) THEOREM ON SEPARABILITY OF ELECTRON PAIRS. Technical Note No. 43.

Apr. 1, 1960. Tadashi Arai. NOTE ON THE SEPARABILITY THEOREM FOR ELECTRON PAIRS. Technical Note No. 44. June 15, 1960. Per-Olov Löwdin (Uppsala Univ.). Contract AF61(052)-351. 21p.

The theorem that two antisymmetric functions ($\Lambda_A(12)$ and $\Lambda_B(12)$ span subspaces), which are mutually perpendicular if the functions are orthogonal to each other in the strong sense $\int \Lambda_A^*(12)\, \Lambda_B(13)\, d\tau_1 = 0$, is proved here. The theorem is important for the study of chemical bonds. (auth)

12895 (ARL-TN-60-177) TESTS OF THE CONVENTIONAL QUANTUM CHEMISTRY METHODS ON THE HYDROGEN ATOM. Technical Note No. 45. T. L. Bailey and J. L. Kinsey (Uppsala Univ.). July 1, 1960. Contract AF61(052)-351. 50p.

In order to test the limitations of the Ritz variation technique in numerical programs involving non-orthogonal functions, the problem of the hydrogen atom was approached in this approximation. The basic functions were chosen from sets commonly used in quantum chemical calculations including simple exponentials; e^{-kr}, k = 1,2, ... and gaussians; e^{-kr^2}, k = 1,2, ... Certain criteria for lower bounds for eigenvalues were also investigated. (auth)

12896 (BNL-644) DIFFUSION OF IODINE THROUGH ALUMINUM. A. W. Castleman, F. E. Hoffmann, and A. M. Eshaya (Brookhaven National Lab., Upton, N. Y.). Sept. 1960. 10p.

The diffusion of iodine through 2S aluminum was studied, with emphasis on the effect of temperatures higher than those for normal fuel element operation, i.e., analogous to those occurring during a reactor temperature excursion. Three independent experimental techniques were used. The first type of experiment, carried out in a sealed capsule, provided a sensitive method of determining diffusivities accurately at low iodine partial pressures by use of radioactive tracer iodine. The second type of experiment was designed to determine the solubility of iodine in aluminum and the diffusivities by unsteady state measurements. The third technique provided a method of measuring permeabilities with the use of radioactive tracer iodine at partial pressures much higher than those attainable with the first technique. Iodine did not diffuse through aluminum in the temperature range 300 to 500°C. Results indicate that iodine may penetrate aluminum by what is essentially a corrosion mechanism, if sufficient quantities are present to sustain the reaction. (auth)

12897 (CEA-1334) COMPARISON DES MÉTHODES DE MESURE DE LA CAPACITÉ D'ÉCHANGE D'IONS D'UN SOL. MISE AU POINT D'UNE METHODE RAPIDE. (Comparison of Methods for Measuring the Ion Exchange Capacity of a Soil. Development of a Quick Method). R. Amavis (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1959. 9p.

In a study on the movement of radioactive ions in soil, the cationic exchange capacity of various soil samples was measured. The methods used are described and the results obtained are compared. A colorimetric method, using $CO(NH_3)_6^{3+}$ as exchangeable ion, was developed. It gives results comparable to those obtained with conventional methods. The time necessary for the operations is considerably reduced. (auth)

12898 (CEA-1698) DENSITE DES SOLUTIONS NITRIQUES DE PLUTONIUM. (Density of Nitric Acid Solutions of Plutonium). J. P. Guibergia (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1960. 14p.

An expression for use in determining the density of a nitric acid solution of plutonium is presented. Under certain defined experimental conditions, the equation makes it possible to deduce, for a solution whose concentration, free acidity, and temperature are known, the corresponding value of the density of that solution. (auth)

12899 (CEA-1704) ADSORPTION DES PRODUITS DE FISSION SUR DES VASES DE MEDITERRANEE. (Adsorption of Fission Products on Mediterranean Mud). Pierre Cohen and Claude Gailledreau (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). Sept. 27, 1960. 13p.

Partition coefficients of some fission products have been measured in sea water from mud taken from the bottom of the Mediterranean sea. A discussion on the behavior of these radioisotopes is included. (auth)

12900 (CEA-Bib-9) OXYDATION DU GRAPHITE. (Graphite Oxidation). J. Dirian (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). Jan. 1960. 23p.

References concerning the oxidation of graphites are collected in the present paper. The first part deals with thermal oxidation and the second one with oxidation in the presence of radiations. Abstracts are included. 90 references. (auth)

12901 (DEG-Memo-826) SOME PROPERTIES OF THIN OXIDE FILMS ON SODIUM–POTASSIUM ALLOY SURFACES. D. Sutherland and A. W. Smith (United Kingdom Atomic Energy Authority. Development and Engineering Group, Dounreay, Caithness, Scotland). May 1960. 8p.

The reaction of oxygen at low concentrations in nitrogen with sodium–potassium alloy was investigated. It was found that a thin, almost insoluble, oxide coating forms on the alloy. The coating inhibits the absorption of oxygen at concentrations of 1 to 300 ppm. (J.R.D.)

12902 (NYO-6651) FOURTH ANNUAL REPORT ON DISTRIBUTION STUDIES BETWEEN MELTS AND SOLID PHASES USING RADIOACTIVE TRACERS. R. Ward, W. C. Orr, L. Katz, J. T. Looby, and R. M. Valletta (Connecticut. Univ., Storrs). July 31, 1955. Contract AT(30-1)-1154. 45p.

Cerium(III) ion in a barium chloride flux does not readily exchange with any of the ions in solid $BaZrO_3$ or $BaTiO_3$. It reacts to form new solid phases, which are identified, and does not enter the original crystal lattices at an appreciable rate. The strontium was found to exchange at a measurable rate with barium in $BaTiO_3$ and with the corresponding ions in alkaline-earth zirconates. Results of a series of equilibrium and rate measurements were interpreted to show that the exchange produces an additional solid phase, $SrTiO_3$, rather than the mixed phase, or solid solution, that might have been expected. The significance of this observation is discussed. The self-exchange of yttrium ions between a solid compound of yttrium and an alkali chloride flux in which yttrium chloride is dissolved appears in the systems studied to depend primarily on the solubility of the solid. Exchange is rapid and complete in the case of yttrium oxychloride, which is soluble to the extent of 0.6%, but is limited to the surface of yttrium chromium oxide, which has no measurable solubility in the flux. The introduction of yttrium ion vacancies in the lattice of yttrium chromium oxide has no detectable effect in promoting exchange. (For preceding period see NYO-3279.) (auth)

12903 (NYO-6652) FIFTH ANNUAL REPORT ON DISTRIBUTION STUDIES BETWEEN MELTS AND SOLID PHASES USING RADIOACTIVE TRACERS. R. Ward, W. C. Orr, L. Katz, J. T. Looby, R. M. Valletta, and T. E.

Burgess (Connecticut. Univ., Storrs). June 30, 1956. Contract AT(30-1)-1154. 21p.

Equilibrium constants for the reaction $Sr^{2+} + BaTiO_3(s) \rightleftharpoons SrTiO_3(s) + Ba^{2+}$ in a flux of molten sodium chloride are reported as 5.9 ± 0.7 (922°C) and 6.7 ± 0.7 (1004°C). A new modification of YOCl was discovered and tentatively identified as having the same structure as the oxychlorides of the smallest rare earths, thulium, ytterbium, and lutetium. It appears to be tetragonal with cell constants (a) = 13.22 A and (c) = 12.04 A. Measurements of the solubility of Y_2O_3 in fluoride-containing melts were interpreted to show that fluoride ion complexes yttrium forming $YF_n^{(3-n)^+}$, where n has an average value of 2.25 for fluoride concentrations in the neighborhood of 10 mole %. Sodalite and noselite, two compounds with an alumino-silicate network lattice, were prepared and are being used in exchange studies. (For preceding period see NYO-6651.) (auth)

12904 (NYO-6653) SIXTH ANNUAL REPORT ON DISTRIBUTION STUDIES BETWEEN MELTS AND SOLID PHASES USING RADIOACTIVE TRACERS. R. Ward, W. C. Orr, L. Katz, T. E. Burgess, Ann M. Strosberg, and L. E. Seufert (Connecticut. Univ., Storrs). June 30, 1957. Contract AT(30-1)-1154. 24p.

An experimental study of the exchange of sodium ions between solid sodalite and melts containing chloride was started. The exchange is rapid and apparently unaffected by the presence of cesium ions in the melt, as the latter are too large to enter the alumino-silicate lattice. A method for the measurement of self-diffusion is described and is being applied to the diffusion of sodium ions in the low-melting $AlCl_3$–NaCl fused-salt system. The method requires filling a capillary diffusion tube with two columns of liquid, one radioactive and one inactive, adjoining each other in a relatively sharp interface. The progress of the diffusion is followed by passing the diffusion tube under a well-collimated radiation detector and observing the changing distribution of the tracer. (For preceding period see NYO-6652.) (auth)

12905 (NYO-6654) SEVENTH ANNUAL REPORT ON DISTRIBUTION STUDIES BETWEEN MELTS AND SOLID PHASES USING RADIOACTIVE TRACERS. R. Ward, W. C. Orr, L. Katz, T. E. Burgess, Ann M. Strosberg, and L. E. Seufert (Connecticut. Univ., Storrs). June 30, 1958. Contract AT(30-1)-1154. 46p.

The study of the exchange of sodium ions between solid sodalite and melts containing sodium chloride was continued. Data showing the exchange at various temperatures and sodium contents are included. Back-scattering and self-absorption factors for radiosodalite containing Na^{22} were determined. The diffusion coefficient, D, for the self-diffusion of sodium ions in the low-melting $AlCl_3$–NaCl fused-salt system was measured. A mathematical treatment of the data obtained by this method is discussed. An equilibrium is postulated explaining the solubility of barium titanate in molten sodium chloride. (For preceding period see NYO-6653.) (auth)

12906 (NYO-9470) A SURVEY REPORT ON LITHIUM HYDRIDE. Charles E. Messer (Tufts Univ., Medford, Mass.). Oct. 27, 1960. Contract AT(30-1)-1410. 64p.

The physical and chemical properties of lithium hydride are described, based on reasonably full coverage of the available unclassified literature as of July 1, 1960. Where possible, the data are presented critically. Lithium deuteride and lithium hydride gases are included. Practical matters such as thermal stability, corrosive character, utilization, handling, fabrication, and analysis are discussed. This report replaces report NYO-3957 and its supplement NYO-8022. 230 references. (auth)

12907 (TID-11466) [THE REACTION BETWEEN U(IV) AND Tl(III)]. Summer Report. E. K. Mellon, Jr. (Los Alamos Scientific Lab., N. Mex.). Aug. 31, 1960. 10p.

Research was conducted to determine if the reaction U(IV)–Tl(III) proceeds by a chain mechanism. It is noted that the work met with no success. Suggested experiments to obtain information on this reaction include a study of the effects of the cuprous ion and a study of the system without argon treatment. (J.R.D.)

12908 (TID-11805) I. DIFFUSION OF WEAK ELECTROLYTES IN AQUEOUS SOLUTIONS. II. DIFFUSION OF HYDROCHLORIC ACID IN AQUEOUS SOLUTIONS (thesis). Eugene Lawrence Holt (Yale Univ., New Haven). 1961. Contract AT(30-1)-1375. 133p.

The diffusion coefficients were determined for acetic acid at 9.03×10^{-4} to 5.55×10^{-2} M and chloroacetic acid at 1.08×10^{-3} to 3.09×10^{-3} M in aqueous solutions. The experimental method used was the Harned conductometric technique. The experimental diffusion coefficients were found to be higher than those which could be calculated from theories assuming no interactions between ionic and molecular species other than the dissociation equilibrium. At concentrations large enough to reduce ionization to values of 1% or less, the calculated and experimental values were found to approach each other. Results are given of preliminary investigations on diffusion of hydrochloric acid in dilute solutions. (B.O.G.)

12909 (AEC-tr-4255) MAGNETIC PROPERTIES OF METAL-NH_3 SOLUTIONS AND THE EQUILIBRIUM CONCENTRATION OF LOCAL CENTERS IN THE DIELECTRIC. M. F. Deigen. Translated from Trudy Inst. Fiz, Akad. Nauk Ukr. S.S.R., 5: 105-18(1954). 28p.

The theory developed for the magnetic properties of metal-ammonia solutions is based on the concept of polarons, color centers, and double color centers. The equilibrium concentration of the local centers in the ionic dielectric is determined as functions of temperature and introduced electron concentration. The coefficients of magnetic susceptibility of the local centers and the coefficient of magnetic susceptibility of the metallic atoms are calculated. The theory embraces ionic crystals with the color centers. The results are in good agreement with experimental data. (auth)

12910 (AEC-tr-4257) THE THEORY OF MAGNETIC PROPERTIES OF METAL-AMMONIA SOLUTIONS. M. F. Deigen. Translated from Zhur. Eksptl'. i Teoret. Fiz., 26: 293-9(1954). 17p.

On the basis of evidence on local electronic centers in ionic dielectrics (polarons, color centers, and double color centers), a theory of the magnetic properties of metal–ammonia solutions was developed. Equilibrium concentrations and coefficients of magnetic susceptibility were determined. The coefficient of magnetic susceptibility for the solution as a function of temperature and metallic atom concentration was also calculated. The theory was confirmed by experiment. (auth)

12911 (AEC-tr-4258) OPTICAL PROPERTIES AND ELECTRICAL CONDUCTIVITY OF METAL-AMMONIA SOLUTIONS. M. F. Deigen. Translated from Zhur. Eksptl'. i Teoret. Fiz., 26: 300-6(1954). 21p.

The dependence of absorption spectra and electrical conductivity and its temperature coefficient as a function of metal concentration in metal-ammonia solutions is explained on the basis of local electronic centers (polarons, color centers, and double color centers) in an ionic dielectric. The position of the maximum and the half-width of the light absorption band is calculated, assuming that light absorption is due to polarons. (auth)

12912 (CEA-tr-R-1063) CORROSION DES JOINTS DE SOUDURE D'ACIERS INOXYDABLES DANS LES SOLUTIONS ACIDES. (Corrosion of Welded Joints of Stainless Steel in Acid Solutions). M. M. Curtepov and A. S. Griaznova. Translated into French by S. Tarassenko from Metalloved. i Termichesk. Obrabotka. Metal., No. 4, 41-4 (1959). 12p.

A study was made of the effects of different heat treatments on the corrosion resistance of argon arc-welded joints in 1 × 18 HGT steel. The treatment involved quenching at 1050°C in water, and reheating to 850°C during 3 hr, and then air cooling. The welding was done with fusible electrode wire with and without titanium at 250 amp, 27 volts and at a rate of 44 m/hr. The weighing method was used. The corrosion tests were carried out in 57% boiling HNO_3 for 200 hr with the solution being replaced at 100 hr. A higher corrosion resistance was observed in non-heat-treated joints, as well as in the nonquenched joints. For all the heat-treatment methods studied, a short anneal noticeably increased the corrosion rate. A stabilization reheat lowered the resistance; however, it proved to be a useful heat-treatment for short successive anneals in the dangerous temperature region. An intercrystalline corrosion concentrated in the fusion zones. The most corrosion occurred with a repeated reheat of short duration (650°C for 2 hr) with titanium stabilization corrosion increased. (T.R.H.)

12913 (CEA-tr-R-1071) MECANISME DE FORMATION DE QUELQUES RADICAUX DANS LA DECHARGE A HAUTE FREQUENCE. (Mechanism of Formation of Certain Radicals in High Frequency Discharges). V. S. Rossikhin and I. L. Tsikora. Translated into French by S. Zarfin from Zhur. Fiz. Khim., 30: 453-6(1956). 11p.

The formation mechanism for the radicals C_2, CH, CN, and OH was studied by examining the spectra produced by high-frequency discharge in CO_2, CCl_4, and mixtures of these compounds with hydrogen and nitrogen. The data obtained confirm the hypothesis formulated previously (Zhur. Khim. Fiz. 29, 1080(1955)) on the mechanism for the formation of C_2. The presence of free atoms of carbon is an indispensable condition for C_2 formation. It was shown that the CH band (4315 A) appears in the spectra produced by discharge in CO_2 and CCl_4 only if hydrogen is present. The most probable mechanism for the formation of CH is the combination reaction of atoms of carbon and hydrogen. (tr-auth)

12914 (UCRL-Trans-642) ADVANCES (PROGRESS) IN THE PHYSICAL SCIENCES DEVELOPMENT OF THE FLUOROMETRICAL METHOD IN THE STUDY OF THE DURATION OF THE EXCITED STATE OF MOLECULES. A. M. Bonch-Bruevich (Bonch-Bruyevich). Translated from Uspekhi Fiz. Nauk 58: 85-110(Jan. 1956). 69p.

A review is presented which includes a summary of basic characteristics of fluorometers developed since 1950, an analysis of measurement error sources in phase fluorometers, and developments in the area of phase fluorometers. The design and uses of a phase fluorometer is described, the resolving power of which is about 2.10^{-11} sec at a low level of fluctuation interferences. This exceeds, by about one order, the resolving power of the best fluorometers previously described. (J.R.D.)

12915 ISOTOPIC EXCHANGES OF OXYGEN ATOMS IN SILICATES. J. Wyart (Faculte des Sciences, Paris), G. Sabatier, H. Curien, G. Ducheylard, and M. Severin. Bull. soc. franc. mineral. et crist., 82: 387-9(1959). (CEA-1630). (In French)

The isotopic exchange of oxygen between a sample of silicate or granite and O^{18}-enriched water is studied experimentally in the temperature region from 360 to 800°C and at pressures between 500 and 800 bars. Even under the most unfavorable conditions, this isotopic exchange is considerable; it is greatly increased by melting of the sample. These facts support the hypothesis of a reaction of water on the tectosilicates, in which the ions H^+ and OH^- break the Si−O−Si and Al−O−Si bonds. (auth)

12916 INFLUENCE OF DECOMPOSITION PRODUCTS ON THE HEAT OF REACTION OBSERVED BY DIFFERENTIAL THERMAL ANALYSIS. Case of Thorium Oxalate. Bernard Claudel, Marcel Perrin, and Yves Trambouze (Faculte des Sciences, Lyon and Institut de Recherches sur la Catalyse, Villeurbanne, France). Compt. rend., 252: 107-9(Jan. 4, 1961). (In French)

Differential thermal analyses made on thorium oxalate show that the thermicity of the phenomenon changes direction according to whether the analysis is made in the presence of oxygen. This effect can be attributed to combustion reactions of the decomposition products. (tr-auth)

12917 MASS-SPECTROMETER STUDY OF CESIUM HALIDES. P. A. Akishin, L. N. Gorokhov, and L. N. Sidorov (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R., 135: 113-16(Nov. 1, 1960). (In Russian)

A mass spectrometric analysis was made of Cs_2F_2, Cs_2Cl_2, Cs_2Br_2, and Cs_2I_2 in order to determine the composition of the vapor and to measure the heat of dissociation of dimeric molecules. (R.V.J.)

12918 ON THE INTERPRETATION OF ELECTRONIC AND VIBRATION SPECTRA OF URANYL NITRATES. L. V. Volod'ko, A. N. Sevchenko, and D. S. Umreiko (Lenin Belorussian State Univ., USSR). Doklady Akad. Nauk S.S.S.R., 135: 560-3(Nov. 21, 1960). (In Russian)

The infrared absorption spectra of hexahydrous uranyl di- and trinitrate in acetone were analyzed. Uranyl trinitrate was prepared by mixing equimolar solutions of hexahydrous uranyl nitrate with tetraethylammonium nitrate in acetone at room temperature. The infrared spectra of 0.2 M concentrates were recorded with a two-ray spectrometer. The plotted spectra differ from each other in absorption intensity distribution. A tabulation of infrared absorption lines indicates the appearance of a considerable number of anion oscillation frequencies in addition to the UO_2^{2+} frequencies, indicating a covalent character in the anion bond with uranyl. In contrast to the infrared spectra, the electron absorption spectra undergo considerable alterations during trinitrate formation. The third nitrate group induces stronger absorption in the long-wave bands (21404, 22114, 22831, and 23545 cm^{-1}) while the rest of the spectrum undergoes no noticeable changes. Sharp absorption lines are also observed in the ultraviolet region where the absorption lines for all uranyl compounds are usually monotonous. The dichromism of absorption and the dependence of fluorescence polarization on excitation frequency indicate four electron transitions in the examined spectrum. The data show that changes in the absorption spectra during the dinitrate transition to trinitrate take place as a result of second and fourth electron shifts. (R.V.J.)

12919 CHEMICAL DISPLACEMENTS OF THE MAGNETIC RESONANCE OF FLUORINE NUCLEUS IN IONIC CRYSTALS. I-ch'iu Wang (Leningrad State Univ.). Doklady Akad. Nauk S.S.S.R., 136: 317-19(Jan. 11, 1961). (In Russian)

Chemical displacements of F^{19} in CsF, KF, LiF, NaF, RbF, BaF_2, CaF_2, MgF_2, and SrF_2 were measured in order to determine the electron structure of solids, the position of the free F^- resonance, and the influence of surrounding

medium on the ion. The latter plays a considerable part in the theory of the chemical displacement in fluorine magnetic resonance. An automatic recording radiofrequency spectrometer was used in the experiments. The plotted results show that the chemical displacement of fluorine magnetic resonance lines, and hence the magnetic screening, diminish with the increase of atomic number (all except LiF). It was also observed that bound fluorine ions differ from free ions. Further analysis was made for the purpose of determining the degree of electron shell overlapping in the first group of metals. (R.V.J.)

12920 SYNTHESIS AND THERMAL STABILITY OF THE DIHYDRATES OF ZIRCONIUM AND HAFNIUM OXYNITRATES. L. N. Komissarova, L. I. Yuranova, and V. E. Plyushchev (Moscow State Univ.). Doklady Akad. Nauk S.S.S.R., 136: 350-3(Jan. 11, 1961).

Thermal investigations supported by x-ray phase analysis and chemical analysis show that dihydrates of zirconium and hafnium oxynitrates are thermally unstable and disintegrate completely at 400°C. Hafnium decomposes in stages, followed by the formation of monohydrate and unstable oxynitrate with an oxide ratio of $HfO_2 : N_2O_5 = 2 : 1$. The thermal treatment of $ZrO(NO_3)_2 \cdot 2\ H_2O$ does not produce monohydrate and its intermediate compounds are expressed less clearly than in hafnium. (R.V.J.)

12921 COMPOUNDS OF HEPTAVALENT RHENIUM WITH THE PEROVSKITE STRUCTURE. Arthur W. Sleight and Roland Ward (Univ. of Connecticut, Storrs). J. Am. Chem. Soc., 83: 1088-90(Mar. 5, 1961).

The compounds $Ba(Na_{0.5}Re_{0.5})O_3$ and $Ba(Li_{0.5}Re_{0.5})O_3$ was prepared by interaction of rhenium metal with barium and alkali carbonates at 900°. They form a continuous series of solid solutions. The structure is shown to be of the ordered perovskite type in which the alkali metal ions and the rhenium(VII) ion are in sixfold coördination with oxygen. (auth)

12922 ONE STEP OXIDATION OF THALLIUM(I) TO THALLIUM(III). J. W. Gryder and Mary C. Dorfman (Johns Hopkins Univ., Baltimore). J. Am. Chem. Soc., 83: 1254-5(Mar. 5, 1961).

A preliminary report of the oxidation of Tl(I) by Ce(IV) in 6.18 F HNO_3 at 53.9° is presented to prove that a two-electron transfer occurs in some oxidations of Tl(I), probably by an oxygen atom transfer. (N.W.R.)

12923 KINETICS OF COORDINATE BOND FORMATION. IV. KINETIC ISOTOPE EFFECT IN THE REACTION $NH_3 + BF_3$. G. B. Kistiakowsky and C. E. Klots (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 34: 712-14 (Mar. 1961).

An isotopic-rate ratio $k'/k = 1.91 \pm 0.10$, was measured at room temperature for the reaction NH_3 (ND_3) + BF_3 = NH_3BF_3 (ND_3BF_3). A set of vibrational frequencies for the transition states was deduced which explains the observation by attributing to the transition state a large degree of charge-transfer stabilization and a negligible activation energy. (auth)

12924 KINETICS OF COORDINATE BOND FORMATION. V. KINETICS OF THE REACTION $P(CH_3)_3 + BF_3$. G. B. Kistiakowsky and C. E. Klots (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 34: 715-71(Mar. 1961).

The temperature pattern method in dilute spherical diffusion flames was applied to the reaction of boron trifluoride with trimethyl phosphorus. The bimolecular rate constant indicates this to be the fastest association reaction ever studied with this technique. The effect of the reverse reaction on the temperature pattern is qualitatively confirmed. The origin of steric factors in coordinate bond formation is briefly discussed. (auth)

12925 OXYGEN ISOTOPE FRACTIONATION BETWEEN CALCIUM CARBONATE AND WATER. Robert N. Clayton (Univ. of Chicago). J. Chem. Phys., 34: 724-6(Mar. 1961).

A technique is described for the total extraction of oxygen from calcium carbonate for isotopic analysis. This permits recalculation of previously published data to yield absolute values of equilibrium constants for the oxygen isotope exchange reaction between calcite and water. The equilibrium constant varies with temperature according to the empirical relationship $\ln K = 2730\ T^{-2} - 0.00256$ over the temperature range 273 to 1023°K. (auth)

12926 INTRAMOLECULAR ENERGY TRANSFER IN RARE EARTH CHELATES. ROLE OF THE TRIPLET STATE. G. A. Crosby, R. E. Whan, and R. M. Alire (Univ. of New Mexico, Albuquerque). J. Chem. Phys., 34: 743-8(Mar. 1961).

Results of luminescence studies on chelates of La^{3+}, Sm^{3+}, Eu^{3+}, Gd^{3+}, Tb^{3+}, Dy^{3+}, Tm^{3+}, Yb^{3+} and Lu^{3+} are reported. It is shown that the intramolecular energy-transfer efficiency is a sensitive function of the relative positions of the resonance energy levels of the ions and the metastable triplet states of the complexes. In the case of Eu^{3+} it is demonstrated that, by a proper choice of ligands, it is possible to selectively excite only the lowest resonance level of the two existing resonance levels of this ion. Coupling of the rare earth ions to the ligands is discussed, and a comparison is made between the optical properties of rare earth ions in chelates and in inorganic salts. (auth)

12927 ELECTRICAL RESISTIVITY OF LIQUID SODIUM, LIQUID LITHIUM, AND DILUTE LIQUID SODIUM SOLUTIONS. J. F. Freedman (IBM Research Center, Yorktown Heights, N. Y.) and W. D. Robertson. J. Chem. Phys., 34: 769-80(Mar. 1961).

The three factors of atomic size, ion core potential, and charge, which contribute to the increment in electrical resistivity produced by solutes in metallic solutions, were separated and experimentally evaluated in liquid sodium. The results may be expressed in a semiempirical relation defining the increment in resistivity of a monovalent solution, $\Delta\rho = 0.063|\Delta \text{ Atomic Number}| + 0.53\ (\Delta V/V)^2$, μohm cm/at.%, where $\Delta V/V$ is the fractional difference in atomic volume of solute and solvent and the first term involves the absolute value of the difference in atomic number of sodium and the solutes lithium, potassium, cesium, rubidium, silver, and gold. (auth)

12928 SYNTHESIS OF THE CUBIC FORM OF BORON NITRIDE. R. H. Wentorf, Jr. (General Electric Research Lab., Schenectady, N. Y.). J. Chem. Phys., 34: 809-12 (Mar. 1961).

A study of the formation of cubic boron nitride shows that the alkali and alkaline earth metals and their nitrides are effective catalysts for converting hexagonal boron nitride into cubic. The pressure and temperature required vary with the catalyst, and a minimum of about 45,000 atm and 1500°C was found to be optimum. (auth)

12929 STRUCTURE OF ALKALI METALS IN THE LIQUID STATE. N. S. Gingrich and LeRoy Heaton (Argonne National Lab., Ill.). J. Chem. Phys., 34: 873-8(Mar. 1961).

Neutron diffraction patterns were obtained for the alkali metal liquids; lithium (180°C), sodium (100°C), potassium (65°C), rubidium (40°C, 160°C, 240°C, and 360°C), and cesium (30°C, 300°C, and 575°C). It was found necessary to correct intensities for scattering by a free atom for lithium and sodium, but not for the heavier atoms. Atomic distribu-

tion curves were computed for all the above cases and compared with results from x-ray diffraction. Just above melting temperatures, the nearest-neighbor distances are for lithium, 3.15 A; sodium, 3.82 A; potassium, 4.64 A; rubidium, 4.97 A; and cesium, 5.31 A. The number of nearest neighbors is, within one-half atom, about 9.0 to 9.5 atoms in each case. At elevated temperatures with rubidium and cesium, a weak subsidiary concentration of atoms appears between the usual first and second neighbor concentration. (auth)

12930 HIGH-SPEED COMPUTATIONS IN DIFFUSION KINETICS. III. SOLUTE DEPLETION IN THE CYLINDRICAL ONE RADICAL-ONE SOLUTE MODEL. Hugo Fricke and David L. Phillips (Argonne National Lab., Ill.). J. Chem. Phys., 34: 905-8(Mar. 1961).

The earlier study [D. A. Flanders and H. Fricke, J. Chem. Phys. 28, 1126 (1958)] of the kinetic properties of a cylindrically symmetric one radical-one solute model was extended by taking account of the transient dilution of the solute which occurs during the reaction. The results of the computations are collected in a table from which, by interpolation, I_R, the fraction of radicals recombining, can be obtained for any experimentally important values of the four dimensionless parameters that define the problem. Under conditions of practical interest, the effect of solute depletion on I_R is appreciable only when the ratio of the rate constants of radical-solute and radical-radical reactions is above 0.1 and only slightly affected by the diffusion coefficient of the solute. The role played by solute depletion is elucidated by graphs representing the transient course of the reactions. (auth)

12931 EFFECT OF PRESSURE ON THE SPECTRA OF FIVE NICKEL COMPLEXES. D. R. Stephens and H. G. Drickamer (Univ. of Illinois, Urbana). J. Chem. Phys., 34: 937-40(Mar. 1961).

The effect of pressure to 150 kbars was measured on the absorption spectra of five nickel complexes. The results are in terms of the change of 10 Dq and of the Racah parameter B, with pressure. In general 10 Dq, the crystal field strength, increased with pressure, but the increase noted was not the same when calculated for the different peaks of a given complex. This discrepancy may be described in terms of changes of covalency as measured by changes of the Racah parameter B. In general, B decreased with increasing pressure showing increased covalency at high pressure. There were some discrepancies in the value of B obtained from different transitions. These may be the result of experimental error but may also be associated with distortions of the field or with weaknesses in the assumption of point charges or dipoles. (auth)

12932 INFRARED SPECTRUM OF SINGLE CRYSTALS OF LiOH, LiOD, AND LiOH · LiOD. R. H. Hexter (Mellon Inst., Pittsburgh). J. Chem. Phys., 34: 941-7(Mar. 1961).

High-resolution infrared absorption spectra of single crystals of LiOD and of the solid solution LiOH · LiOD are reported. These are compared with each other and with the spectrum of monocrystalline LiOH. Comparisons with the spectra of $Mg(OH)_2$ and $Ca(OH)_2$ are also made. The differences in selection rules for the two types of hydroxides are discussed together with differences in spectra to be expected upon changing the mass of the cation and upon deuterium substitution. The discussion is in terms of the current theory of the spectra of such crystals. It is concluded that the complex spectrum of these minerals in the high-frequency region (2000 to 5000 cm^{-1}) is entirely due to OH^- (or OD^-) ion motion. The motion is quite localized; the motions of the several OH^- ions of the crystal are poorly coupled. Difficulties with previous assignments due to unusual temperature dependencies of intensities are also discussed. The restricted rotational character of the localized motion of the OH^- ions, previously proposed, may be used to rationalize these difficulties and to qualitatively account for the existence and similarity of the spectra of all three materials. The "rotational" model accounts well for the frequency shifts consequent on deuteration. (auth)

12933 CORE POLARIZATION IN Li_2. Oktay Sinanoğlu and Earl M. Mortensen (Univ. of California, Berkeley). J. Chem. Phys., 34: 1078-9(Mar. 1961).

The contribution of core polarization to the small binding energy of Li_2 and its sensitivity to the crudeness of the outer molecular orbitals used was examined by calculated values. Callaway's potential V_p resulting from the instantaneous polarization of (Li^+) by a slow electron. The main parting coming from the dipole terms, was used. Results showed that core polarization contributed appreciably to the total energies of Li and Li_2; however, the effects on the two almost cancel and yield a small contribution to the binding energy. (N.W.R.)

12934 VAPORIZATION OF SEVERAL RARE EARTH OXIDES. Morton B. Panish (Avco Corp., Wilmington, Mass.). J. Chem. Phys., 34: 1079-80(Mar. 1961).

The vaporization of Pr_2O_3, Nd_2O_3, Sm_2O_3, and Eu_2O_3 was studied at temperatures from 1950 to 2350°K by analyzing the species effusing from a Knudsen cell with a time-of-flight mass spectrometer. The vaporization of the oxides under neutral conditions was stoichiometric. X-ray analyses of the oxides after heating indicated that only the oxides were present at the end of the run. (N.W.R.)

12935 A CONVENIENT METHOD FOR THE PREPARATION OF [^{36}Cl] CHLORINE FROM [^{36}Cl] HYDROCHLORIC ACID: DECOMPOSITION OF PALLADOUS [^{36}Cl] CHLORIDE. I. C. McNeill (Univ. of Durham, Eng.). J. Chem. Soc., 639-41(Feb. 1961).

Quantitative yields of chlorine may be obtained by thermal decomposition of palladous chloride around 600°C in vacuo. Cl^{36} is conveniently obtained in a vacuum system if the palladous chloride is labeled by exchange with hydrochloric acid (Cl^{36}) before decomposition. The specific activity of the chlorine obtained is shown to be the same as that expected from the initial proportions of palladous chloride and hydrochloric acid (Cl^{36}) selected. (auth)

12936 THE THERMAL DECOMPOSITION OF PLUTONIUM HEXAFLUORIDE. L. E. Trevorrow, W. A. Shinn, and R. K. Stuenenberg (Argonne National Lab., Ill.). J. Phys. Chem., 65: 398-403(Mar. 1961).

Stoichiometric and equilibrium determinations were made of the thermal decomposition reaction of plutonium hexafluoride at temperatures from 150 to 400°. The reaction products under these conditions were gaseous fluorine and solid plutonium tetrafluoride. Below 300°, the equilibrium constants (moles PuF_3/moles F_2) were found to be higher than literature values. The sharp change in the relation between log K and 1/T at 308° reported previously was not found in the present work. The relation between equilibrium constant and temperature is expressed by the equation $\log K = -1331/T(°K) - 0.275$. (auth)

12937 A THERMODYNAMIC STUDY OF THE SYSTEM AMMONIUM FLUORIDE–WATER. I. THE HEAT CAPACITY AND THERMODYNAMIC FUNCTIONS OF AMMONIUM FLUORIDE MONOHYDRATE. Leonard C. Labowitz and Edgar F. Westrum Jr. (Univ. of Michigan, Ann Arbor). J. Phys. Chem., 65: 403-8(Mar. 1961).

Thermal analysis and solubility determinations on the

NH_4F-rich side of the NH_4F-H_2O eutectic indicate a peritectic temperature of 246.0°K and a eutectic temperature of 244.15°K, in contrast with 256.4 and 246.7°K, respectively, reported by Yatlov and Polyakova. The existence of the compound $NH_4F \cdot H_2O$ at 245.7°K was established by application of the method of wet residues to the system $NH_4F-NH_4I-H_2O$ at that temperature. The heat capacity of the monohydrate was determined from 5 to 323°K. The values of the saturation heat capacity, C_s, and the derived thermodynamic functions S^0; $H^0 - H_0^0$, and $(F^0 - H_0^0)/T$ at 298.15°K are 37.22 cal/(deg mole), 34.92 cal/(deg mole), 6146 cal/mole, and −14.30 cal/(deg mole), respectively. The enthalpy increment of the peritectic reaction is 1360 cal/mole at 246°K. (auth)

12938 A THERMODYNAMIC STUDY OF THE SYSTEM AMMOUIUM FLUORIDE–WATER. II. THE SOLID SOLUTION OF AMMONIUM FLUORIDE IN ICE. Leonard C. Sabowitz and Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor). J. Phys. Chem., 65: 408-14(Mar. 1961).

The existence, range, and thermodynamic properties of the solid solution in the NH_4F-H_2O system were established by thermal analysis, solubility determinations, Schreinemakers' method of wet residues, and equilibrium adiabatic calorimetry. Some of the results are at variance with those reported by Yatlov and Polyakova, and the deviations have been explained when possible. Heat capacity measurements were made from 55 to 325°K on systems of composition, 0.5, 1.5, and 4.6 mole % of NH_4F, and on the eutectic composition. No eutectic halt was observed in the case of the first two solutions, giving further confirmation of the existence of a solid solution at these concentrations. A theoretical relationship for the solidus curve is in accord with the experimental data obtained by the various methods.(auth)

12939 THE FLUORIDE COMPLEXING OF YTTRIUM(III) IN AQUEOUS SOLUTION. Armine D. Paul, Linda S. Gallo, and Jean B. VanCamp (West Virginia Univ., Morgantown). J. Phys. Chem., 65: 441-3(Mar. 1961).

The fluoride complexing of Y^{3+} in perchlorate solution was studied potentiometrically by measuring the effect on the known ferric fluoride equilibria using the ferrous-ferric electrode. At 25° and an ionic strength of 0.5M the equilibrium quotients for the reactions $Y^{3+} + HF = YF^{2+} + H^+$, $YF^{2+} + HF = YF_2^+ + H^+$, and $YF_2^+ + HF = YF_{3(aq)} + H^+$ are 10.0, 2, and 2, respectively. Equilibrium quotients are also given at 15 and 35°. The stability of the yttrium fluoride complexes is compared with that of other trivalent ions. The decrease in stability of successive fluoride complexes of Y^{3+} is less than that for other trivalent ions.(auth)

12940 COMPLEX IONS IN FUSED SALTS. SILVER HALIDES. F. R. Duke and H. M. Garfinkel (Ames Lab., Ames, Iowa). J. Phys. Chem., 65: 461-3(Mar. 1961).

The system $AgNO_3-KX$ in sodium–potassium nitrate eutectic solvent was investigated by following the electromotive force as a function of the concentration of either chloride or bromide ion. Since the silver nitrate electrode shows Nernst behavior, the deviations from such behavior were ascribed to complex ion formation. Several determinations were made at various temperatures and equilibrium and standard heats of reaction were tabulated for the different species postulated. (auth)

12941 THE THERMAL DECOMPOSITION OF ANHYDROUS URANYL NITRATE AND URANYL NITRATE DIHYDRATE. R. S. Ondrejcin and T. P. Garrett, Jr. (E. I. du Pont de Nemours & Co., Aiken, S. C.). J. Phys. Chem., 65: 470-3(Mar. 1961).

The thermal decomposition of anhydrous uranyl nitrate followed first-order kinetics in vacuo at temperatures from 250 to 450°. Amorphous uranium trioxide was the only nonvolatile product of decomposition. No intermediate compounds were observed. The thermal decomposition of uranyl nitrate dihydrate occurred as two independent reactions following first-order kinetics: dehydration to form anhydrous uranyl nitrate and denitration to form uranium trioxide. The decomposition was studied both in vacuo and at atmospheric pressure under nitrogen, at temperatures from 250 to 400°. Intermediate and final decomposition products were identified. The specific reaction-rate constants were measured for the dehydration and denitration reactions. From these data, the heats and entropies of activation were calculated. (auth)

12942 THE PALLADIUM–CHLORINE SYSTEM AT HIGH TEMPERATURE. Wayne E. Bell, Ulrich Merten, and M. Tagami (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Phys. Chem., 65: 510-17 (Mar. 1961).

The palladium–chlorine system was studied over the range 500 to 1500° and a chlorine pressures up to 1 atm. $PdCl_2$ is the only solid chloride that is stable in this range, and its melting point was determined as 680 ± 2°. The solubility of palladium in liquid $PdCl_2$ is small near the melting point of the compound, but increases with temperature. At 980°, the liquid in equilibrium with palladium contains 61 at.% chlorine and has a dissociation pressure of 1 atm. Studies of the effect of chlorine pressure on vapor pressure indicate that the important gaseous species are $PdCl_2$ and a gaseous polymer Pd_5Cl_{10}. At 1-atm. chlorine pressure, $Pd_5Cl_{10}(g)$ is the principal species below 980°, reaching a maximum partial pressure of 12×10^{-3} atm. at 850°. Above 980°, $PdCl_2(g)$ becomes the main species, and at 1506° it has a partial pressure of 0.1 atm. at 1-atm. chlorine pressure. Thermodynamic quantities were determined from the dissociation-pressure and vapor-pressure data. (auth)

12943 THERMODYNAMIC PROPERTIES OF GASEOUS RUTHENIUM CHLORIDES AT HIGH TEMPERATURE. Wayne E. Bell, M. C. Garrison, and Ulrich Merten (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Phys. Chem., 65: 517-21(Mar. 1961).

The thermodynamic properties of the gaseous ruthenium chlorides were studied over the range 650 to 1500° and at chlorine pressures from 0.1 to 1.5 atm. The effect of chlorine pressure on vapor pressure indicates that the important vapor species are $RuCl_4$ and $RuCl_3$. Over $RuCl_3(s)$ at a chlorine pressure of 1 atm., $RuCl_4(g)$ is the principal species, reaching a maximum partial pressure of 0.065 atm. at 853°—the temperature at which $RuCl_3(s)$ decomposes. Above 853°, where Ru(s) is the stable condensed phase, the partial pressure of $RuCl_4(g)$ decreases with increasing temperature, and $RuCl_3(g)$ becomes the principal species. At 1500°, the partial pressure of $RuCl_3(g)$ in equilibrium with Ru(s) and 1-atm. Cl_2 is 0.16 atm. Thermodynamic quantities were determined for the reactions and species studied. (auth)

12944 THE EQUILIBRIUM $2/3Bi(l) + 1/3BiI_3(g) = BiI(g)$. Daniel Cubicciotti (Stanford Research Inst., Menlo Park, Calif.). J. Phys. Chem., 65: 521-3(Mar. 1961).

The equilibrium $2/3\ Bi(l) + 1/3\ BiI_3(g) = BiI(g)$ was studied by a transpiration technique over the temperature range 545 to 735° and the pressure range 0.1 to 50 mm. The enthalpy change for the reaction was 21 kcal and the standard entropy 16 eu at mid-temperature. An excess pressure of reduced Bi species in the higher pressure range was interpreted as due to the formation of a polymer, Bi_nI_n. (auth)

12945 SELF-DIFFUSION OF LIQUID MERCURY. Robert E. Meyer (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 65: 567-8(Mar. 1961).

Self-diffusion measurements were made, using the capillary-reservoir technique, to check the temperature dependence of the diffusion coefficient over a wide temperature range. The results indicate that the Stokes-Einstein and Eyring expressions are favored for diffusion coefficient values. Convection error at high temperature shows more effect in other equations. (N.W.R.)

12946 STRUCTURE AND IONIZATION POTENTIAL OF Hf III AND Hf IV. P. F. A. Klinkenberg, Th. A. M. van Kleef, and P. E. Noorman (Universiteit, Amsterdam). Physica, 27: 151-2(Feb. 1961). (In English)

Structure and ionization potential of hafnium (III) and (IV) were analyzed. As a result, almost 80% of all known Hf III lines were classified as combinations between a low group of 13 even levels belonging to the configurations $5d^2$, 5d6s and $6s^2$, a group of 16 odd levels produced by 5d6p and 6s6p, and 11 high even levels of the 5d7s and 5d6d configurations. The ionization potential derived from the ns^2S series is 33.30v, with a possible error of about 0.05v. The levels of Hf IV that could be established were $5p^65d$, $5p^66s$, $5p^66p$, $5p^67s$, and $5p^66d$. From the two known members of the ns^3D series converging to the limit Hf IV $5d^2D$ the ionization potential is 23.2v, accurate to within a few 0.1v. (N.W.R.)

12947 CHEMICAL PROPERTIES IN THE FUSED LiCl–KCl EUTECTIC. Guy Delarue (Ecole Superieure de Physique et de Chimie, Paris). Rec. trav. chim., 79: 510-17 (June 1960). (CEA-1634). (In French)

A qualitative study was made of the solubility of metallic oxides and sulfides in the fused LiCl–KCl eutectic. The intensity-potential curves show that the solutions obtained contain the O^{2-} and S^{2-} particles which may be oxidized chemically or electrochemically, respectively. (auth)

Radiation Chemistry and Radiochemistry

12948 (NAS-NS-3013) THE RADIOCHEMISTRY OF BERYLLIUM. A. W. Fairhall (Washington. Univ., Seattle. Department of Chemistry). May 1960. 58p.

12949 (NAS-NS-3020) THE RADIOCHEMISTRY OF THE RARE EARTHS, SCANDIUM, YTTRIUM, AND ACTINIUM. P. C. Stevenson and W. E. Nervik (California Univ., Livermore). Feb. 1961. 291p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

12950 (NAS-NS-3021) THE RADIOCHEMISTRY OF TECHNETIUM. Edward Anders (Chicago. Univ.). Nov. 1960. 50p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

The radiochemistry of technetium is discussed. The properties of metallic technetium, solution chemistry, volatilization methods, extraction into organic solvents, chromatographic behavior and electrochemical behavior of technetium are outlined. The dissolution of samples containing compounds of technetium is described. Counting techniques for use with isotopes of technetium are reviewed. A collection of 17 detailed radiochemical procedures for the determination and separation of technetium is given. (M.C.G.)

12951 (ORO-367) NUCLEAR CHEMISTRY RESEARCH. Annual Progress Report. Arthur Fry and R. W. Fink (Arkansas. Univ., Fayetteville). Jan. 1, 1961. Contract AT(40-1)-277. 86p.

The results of experiments and planned work of the Department of Chemistry, Arkansas University, in nuclear chemistry and physics, theoretical physics, and organic isotope chemistry are discussed. The absolute activation cross sections for 14.8-Mev neutrons were determined for a large number of isotopes, and a new isotope was found in the $Fe^{54}(n,t)$ reaction. The (n,2p) reaction was studied in detail. A number of (n,He^3) and (n,t) reactions were studied. A literature survey (up to 1958) was made for cross sections of neutron-induced reactions around 14 Mev. The (n,p) reaction survey was continued up to date. The literature data have a large spread with factors of 2 to 10. Equations were derived from the (n,p) data giving the cross section as a function of atomic number and mass. The yields for U^{238} 14-Mev fission were measured at mass numbers 89, 91, 131, 133, 139, and 140. Radiation effects in plastics were studied. The theoretical aspects of molecular excitation resulting from β decay of a constituent atom are being studied. Calculations were made on the wave functions of the ground state of the helium atom. The acid-catalyzed rearrangements of ketones were studied with both labeled and unlabeled compounds. No cyclic ketones were found to rearrange. The mechanism of the oxygen exchange between benzyl and substituted benzyl alcohols and water was studied with O^{18} tracer. The oxygen exchange between water and benzophenones was also studied. The chlorine isotope effects in displacement reactions of benzyl and substituted benzyl chlorides with various nucleophiles were investigated; the results show a relation between isotope effect and reaction kinetic order. The C^{14} isotope effect on the S_N2' reaction of 3-chloro-1-butene-1-C^{14} with diethylamine was measured. A preliminary measurement was made of the N^{15} isotope effect in the Curtis rearrangement. (See also ORO-182.) (D.L.C.)

12952 (TID-11009) ACTIVATION ANALYSIS; NUCLEAR CHEMICAL RESEARCH; RADIOCHEMICAL SEPARATIONS. Progress Report No. 9, November 1959–October 1960. R. S. Maddock and W. W. Meinke, eds. (Michigan. Univ., Ann Arbor). Nov. 1, 1960. Contract AT(11-1)-70. 139p.

Operation of the Ford Nuclear Reactor at a power of 1 Mw during the period is reported. The pneumatic tube system, operated routinely, and a rabbit design modification are reported, which reduced transit time and radiation exposure. Design, installation, and operation of a Cockcroft-Walton type neutron generator including components are reported. Operational data indicate that at least the lower limits of thermal and fast neutron fluxes are available with this system, and it appears that generators of this type may be useful to many laboratories as an intermediate level source of neutrons. Operation of a 100-channel analyzer during the period is described, and experience with NaI (Tl) crystals is summarized. Preliminary data indicate that a rapid fission gas separation can be used to obtain information for determination of independent fission yields for the chains of mass number 87. A series of γ-ray spectral data from such an experiment is included. Efforts devoted to radiochemical separations are summarized, and data on time consumed in each step of a rapid separation procedure are tabulated. An investigation of rhodium activation analysis is reported in which samples were irradiated in a thermal neutron flux. Rhodium is determined by measuring the counts in the 550-kev γ peak. Another method in which the irradiated sample is fused in Na_2O_2, dissolved in HCl, and subsequently determined absorptiometrically is also described. In other work preliminary

experiments for activation analysis of silver are summarized, and activation analysis of trace cadmium in vanadium is described. Data on indirect neutron absorption analysis for fluoride using gadolinium fluoride indicate that such techniques may be feasible for determination of non-neutron absorbing elements. Chemical separation procedures are included for titanium, rhodium, niobium, silver, cadmium, thallium, and uranium. (For preceding period see AECU-4438.) (J.R.D.)

12953 (TID-11769) STUDIES OF THE RADIATION CHEMISTRY OF ORGANIC COMPOUNDS. THE RADIOLYSIS OF METHANOL AND METHANOLIC SOLUTIONS. Norman N. Lichtin (Boston Univ.). Feb. 28, 1961. Contract AT(30-1)-2383. 8p.

Installation, equipping, and dosimetry of an 850-curie Schwarz-Allen type Co^{60} source were completed. Dose rates are tabulated for six positions in the source. The dissolution of boron from pyrex by methanol was studied using the curcumin procedure. The results indicated $<7 \times 10^{-6}$ M of boron in the methanol independent of irradiations. The gamma radiolysis of methanol resulted in G-values of: 4.66 ± 0.07, H_2; 0.27 ± 0.03, CH_4; 1.94 ± 0.06, CH_2O; and 2.86 ± 0.05, $C_2H_6O_2$. An improvement in the trapping of methanol resulted in the reduction of the apparent yield of H_2 to 3.9. (B.O.G.)

12954 (TID-11887) CARBON-14 ISOTOPE EFFECTS IN THE REACTION OF BENZYL BROMIDE AND OF p-NITROBENZYL BROMIDE WITH SILVER NITRITE. Ernest M. Hodnett and Ray Dean Taylor (Oklahoma State Univ., Stillwater). [nd]. Contract AT(11-1)-71. 19p.

The reaction of benzyl bromide and *p*-nitrobenzyl bromide with silver nitrite to form a nitrite ester and a nitro compound, RONO and RNOO, were studied using compounds labeled with C^{14} at the α position. The C^{14} isotope effect was determined to be 0.956 and 0.894 for the reactions of benzyl bromide and *p*-nitrobenzyl bromide, respectively. The molar ratio of the products (nitrite/nitro) was found to be constant and independent of the relative concentrations of the reactants, indicating that the two products are formed by reactions of the same order. The molar radioactivity ratio of the products in reactions using C^{14}-labeled compounds was found to be constant, and hence it is concluded that both the nitrite ester and nitro compound are formed through a common transition state rather than through two separate transition states. (D.L.C.)

12955 SUBSTANCES LABELLED WITH C^{14} OBTAINED BY γ-IRRADIATION OF MIXTURES CONSISTING OF PROPANE PLUS $C^{14}O_2$ AND CYCLOPENTANE PLUS $C^{14}O_2$. Fulvio Cacace, Giovanna Ciranni, and Elvira Possagno (CNR, Rome and Università, Rome). Ann chim. (Rome), 50: 920-30(1960). (In Italian) (CNEN-17)

Gaseous mixtures consisting of propane, cyclopentane, and $C^{14}O_2$ were irradiated with high doses (10^8 rads) of γ rays. Among the reaction products were carboxylic acids, esters, and ketone labeled with C^{14}. Adding a noble gas (e.g., xenon) to the organic system increased the yield of radioactive compounds. (auth)

12956 LABELLING OF ORGANIC COMPOUNDS BY EXCHANGE WITH TRITIATED WATER. Bianca Aliprandi and Fulvio Cacace (CNR, Rome and Università, Rome). Ann chim. (Rome), 50: 931-4(1960). (In Italian) (CNEN-18)

The application of a labeling method, based on exchange with tritiated water in the presence of perchloric acid, to a series of aromatic compounds including acids, ketones, and polycyclic hydrocarbons is described. This method had been previously used in the preparation of tritiated benzol and toluol. (auth)

12957 SYNTHESIS OF SEVERAL KETONES FROM ACETALDEHYDE AND PROPYLENE BY GAMMA-RAY IRRADIATION. Kozo Hirota and Motoyoshi Hatada (Osaka Lab., Neyagawa City and Osaka Univ.). Bull. Chem. Soc. Japan, 33: 1682-5(Dec. 1960). (In English)

It was found that 2-pentanone and other higher ketones are synthetized in relatively high concentrations by γ-ray irradiation of mixtures of acetadehyde and propylene at room temperature and that the reaction proceeds by a chain mechanism, with the acetyl radical as the initiator. (auth)

12958 RETENTION OF Mn-56 IN NEUTRON-IRRADIATED POTASSIUM PERMANGANATE. Hirotoshi Sano (Tokyo Univ.). Bull. Chem. Soc. Japan, 33: 1738-9(Dec. 1960). (In English)

An experiment is described in which potassium permanganate crystals are bombarded with neutrons at temperatures from 77 to 463°K. The effects of storage times and irradiation temperatures on the retention of Mn^{56} in the permanganate form are studied. (T.F.H.)

12959 A GAS-CHROMATOGRAPHIC APPARATUS FOR THE STUDY OF THE HOT-ATOM CHEMISTRY OF ORGANIC HALIDES. M. D. Silbert and R. H. Tomlinson (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 39: 706-10(Mar. 1961).

The construction of an easily assembled and inexpensive gas-chromatographic apparatus is described. This system was designed to determine β-active materials. The operation of this instrument involves the use of a temperature program in order to resolve materials boiling over a wide range of temperatures. (auth)

12960 HYDRAZINE PRODUCTION BY NUCLEAR REACTION. Curtis P. Fritsch, Jr. (Air Material Command, Wright-Patterson AFB, Ohio), John H. Cusack, Roger I. Miller, and Marvin R. Gustavson. Chem. Eng. Progr., 57: No. 3, 37-41(Mar. 1961).

A nuclear hydrazine production program is described which is designed to determine the feasibility of the direct, in-reactor production of hydrazine from liquid NH_3. In this program fission-fragment recoil energy will be utilized with a suspension of an uranium compound in liquid NH_3. Production costs of hydrazine with this method are estimated conservatively to be in the range of $0.15 to 0.40/lb. The G value to be expected in hydrazine production and design parameters for in-reactor irradiation experiments are discussed. A reaction capsule is designed for the irradiation of 200 ml of liquid NH_3 containing suspended UO_2 or some other uranium compound at a concentration of ~40 g/liter enriched uranium (93% U^{235}). Methods for determining the hydrazine yields and energies deposited are outlined. Some preliminary results obtained in a 5-w AGN-201M reactor are reported in which 4 g NH_3 and 177 mg enriched uranium foil gave a G value of 1.0 to 1.9 for hydrazine production. The parameters to be studied in later experiments are discussed. (D.L.C.)

12961 ON THEORY OF THE THERMALIZATION OF HYDROGEN ATOMS AND THEIR INFLUENCE ON THE YIELD OF THE DIMERIC PRODUCT UPON ALKANE RADIOLYSIS. A. Ya. Temkin (Inst. of Technological Chemical Synthesis, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 135: 373-6(Nov. 11, 1960). (In Russian)

The distribution of hot atoms is studied by the method of energy groups often utilized in neutron thermalization

theory. Passage of hot hydrogen atoms is described by a system of diffusion equations for various monoenergetic groups. The atoms may pass from a higher to a lower energy group. The two-group approximation is applied in an analysis of hot and thermal groups of hydrogen atoms. It is assumed that in inelastic interaction with molecules, hot hydrogen atoms produce a new radical. The two-group method used is equivalent to a two-particle concept in which particles of the first type can transform into particles of the other type. (R.V.J.)

12962 THE EFFECT OF γ-RADIATION OF Co^{60} ON DRY CARBOHYDRATES. M. A. Khenokh, E. A. Kuzicheva, and V. F. Evdokimov (Inst. of Cytology, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 135: 471–4 (Nov. 11, 1960). (In Russian)

The effects of large doses of radiation on dry sugar and polysaccharides were studied. Radioinduced chemical conversions in hydrocarbons are quite similar to those observed in aqueous radiolysis. Identical products, however, were produced only in irradiated saccharose and mannite. In crystalline glucose, fructose, rafinose, and starch, the absorption spectra differed from that of aqueous solutions. In dilute solutions radiochemical changes depend on the reaction of the solute with atomic hydrogen, hydroxyl ions and HO_2 radicals. The effects of ionizing radiation on dry substances induce ionization and excitation of molecules, followed by disintegration and the formation of free radicals that diffuse slowly. The long-life radicals remain in the crystal, which in dissolving, reacts with water producing monosugar and other substances. (R.V.J.)

12963 RELAXATION OF PROTONS IN HYDROGEN PEROXIDE SOLUTIONS IRRADIATED BY ULTRAVIOLET LIGHT. V. M. Vdovenko, E. K. Legin, O. B. Stebunov, and V. A. Shcherbakov (Khlopin Radium Inst., Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 135: 645-7(Nov. 21, 1960). (In Russian)

In order to verify previously reported data, an investigation was made of proton relaxation in irradiated H_2O_2 where the photodecomposition proceeds as a chain reaction with the appearance of a large number of free radicals. Curves of signal variations (ratio of signals from irradiated and nonirradiated solutions) are plotted as functions of radiation time for various concentrations of H_2O_2. All curves are of the same type and are expressed by "so called" saturation curves. (R.V.J.)

12964 THE EFFECT OF γ-RADIATION ON THE AQUEOUS SOLUTIONS OF THIOPHENE. S. A. Safarov, A. I. Chernova, and M. A. Proskurnin (Karpov Inst. of Physics and Chemistry, [USSR] and Inst. of Chemistry, Academy of Sciences, Asiatic SSR). Doklady Akad. Nauk S.S.S.R., 136: 391-3(Jan. 11, 1961). (In Russian)

Effects of γ radiation on oxygen-saturated thiophene in water were studied in order to determine the direction of the oxidation process and the possibility of forming hydroxythiophene. The influence of dissolved product concentrations, the pH of the medium, and other factors on the oxidation process were also analyzed. It was found that the yield of hydroxythiophene depends on the initial concentration of thiophene in the solution. Evaluations made by described methods indicate hydroxythiophene concentrations of 8 eqv/100 ev under favorable conditions. Such yields indicate a significant participation of water molecules in the non-linked oxidation process. (R.V.J.)

12965 DIRECT RADIATION-INDUCED SYNTHESIS OF IODOBENZENE-I^{131} FOLLOWING FISSION PRODUCT RECOIL INTO BENZENE SOLUTION. Donald Ormond and F. S. Rowland (Univ. of Kansas, Lawrence). J. Am. Chem. Soc., 83: 1006-7(Feb. 20, 1961).

Direct recoil of fission fragments into organic solutions was caused by neutron irradiation of 1- to 2-ml samples in quartz tubes internally coated with 1.67 mg of U_3O_8. Organically bound fission-product radioactivity was observed afterward. After irradiation of 12 to 24 hr, more than 50% of the mass 131 atoms recoiling into a benzene solution were determined in iodobenzene-I^{131}. The I^{131} radioactivity in iodobenzene and two derivatives was determined. The yields of inorganic I^{131} and of alkyl iodide–I^{131} were also determined. (M.C.G.)

12966 DEUTERIUM SUBSTITUTION IN AN ELECTRON SPIN RESONANCE STUDY OF RADIATION-INDUCED FREE RADICALS. Ichiro Miyagawa and Walter Gordy (Duke Univ., Durham, N. C.). J. Am. Chem. Soc., 83: 1036-40(Mar. 5, 1961).

Effects of deuterium substitution on the electron spin resonance of x-irradiated organic compounds were investigated. The compounds range from carboxylic acids, amino acids and amides to proteins. Substitution of deuterium for the hydrogens of polar groups—hydroxyl, carboxyl, and amino—showed that the hydrogens of these groups generally do not contribute, or give only a slight contribution, to the hyperfine structure of the resonance pattern. Exceptions were found, however, notably formic acid and glycine. Most often the hydrogens bonded to carbon gave the hyperfine structure of the e.s.r. patterns. In some instances the additional information provided by deuterium substitution allowed a fairly definite identification of the free radicals. (auth)

12967 RADIOLYSIS OF PENTANE IN THE ABSORBED STATE. J. W. Sutherland and A. O. Allen (Brookhaven National Lab., Upton, N. Y.). J. Am. Chem. Soc., 83: 1040-7 (Mar. 5, 1961).

Pentane adsorbed on synthetic zeolites and on silica gel was exposed to γ rays and yields of the various products were studied in detail as a function of pentane content. Radiolysis in the zeolite systems shows a number of peculiar features which depend on the nature of the positive ions present in the zeolite. Radiolysis of pentane adsorbed on silica gel is inhibited by the presence of small amounts of adsorbed salts. Skeletal isomerization is prominent in radiolysis of pentane on silica gel when the pentane content is low but is decreased by the presence of additional pentane or by lowering the temperature of irradiation. The results are discussed in terms of the behavior of excited electrons in solids. (auth)

12968 RADIOLYSIS OF ORGANIC COMPOUNDS. V. n-HEXANE VAPOR. H. A. Dewhurst (General Electric Research Lab., Schenectady, N. Y.). J. Am. Chem. Soc., 83: 1050-2(Mar. 5, 1961).

The radiolysis of n-hexane vapor by 800 kvp electrons gave the product-group yields G (low molecular weight) = 8.6, G (intermediate molecular weight) = 2.3, and G (dimer) = 0.4. The effect of added propylene on these yields was examined; the dimer and intermediate group yields were decreased by about one-half while the low group was changed only slightly. These results are discussed in terms of Futrell's hydride ion-transfer mechanism. In the presence of a tenfold excess of hydrogen the low and intermediate product yields were unchanged, whereas the dimer yield increased threefold. Finally a brief comparison is made of the vapor phase yields and the liquid phase yields. The vapor results show a much higher proportion of products, which must ultimately result from C–C bond cleavage, while the liquid results

show a higher proportion of product, which must result from C–H bond cleavage. (auth)

12969 THE EFFECT OF SOLVENTS ON THE γ-RAY RADIOLYSIS OF METHYL ACETATE AND ACETONE. P. J. Ausloos (National Bureau of Standards, Washington, D. C.). J. Am. Chem. Soc., 83: 1056-60(Mar. 5, 1961).

The effect of cyclohexane and benzene on the radiolysis of CH_3COOCH_3, CH_3COOCD_3, and mixtures of CH_3COCH_3–CD_3COCD_3 was investigated at 17°. In the absence of scavengers, cyclohexane markedly reduces the yield of CO, whereas, in the presence of scavengers, it produces no effect. Benzene inhibits the decomposition of methyl acetate and acetone. Hydrogen is mostly formed in processes involving "hot" hydrogen atoms. The effect of the solvents on the yields of ethanes and some of the methanes indicates the importance of cage and intercage recombinations and disproportionations of the radicals in the γ-ray track. The radiolysis of a CH_3COCH_3–CD_3COCD_3 mixture at −195° is discussed briefly. (auth)

12970 RADIOLYSIS OF AQUEOUS SOLUTIONS HIGHLY ENRICHED IN O^{18}. Michael Anbar (Weizmann Inst. of Science, Rehovoth, Israel), Shmuel Guttmann, and Gabriel Stein. J. Chem. Phys., 34: 703-11(Mar. 1961).

Solutions of $H_2O_2^{16,16}$ in water highly enriched in O^{18} were irradiated with x rays and protons. The effects of H_2O_2 concentration, pH, and bromide and nitrite ions on the yield of the isotopic species $H_2O_2^{16,18}$ and $H_2O_2^{18,18}$ were investigated. The "molecular" H_2O_2 is formed with a G value of 0.3 in neutral solutions. The formation of $H_2O_2^{16,18}$ is attributed to the attack of $O^{18}H$ radicals on $H_2O_2^{16,16}$. The evolved $O_2^{16,18}$ may be regarded as a product of a parallel reaction. The yield of $O_2^{16,18}$ is dependent on an exchange reaction between HO_2 and H_2O_2. Specific effects due to added NO_2^- and high concentration of Br^- are discussed. (auth)

12971 SECONDARY PROCESSES IN A GAS PHASE RADIOLYSIS OF HYDROCARBONS. Jean H. Futrell (Aeronautical Research Labs., Wright-Patterson AFB, Ohio). J. Phys. Chem., 65: 565-6(Mar. 1961).

Differences in irradiation studies of hydrocarbon vapors are shown. Gas-phase radiolysis of n-pentane with Co^{60} γ rays is compared with a previous experiment by Back and Miller on normal hexane radiolysis by 2-Mev electrons. Both experiments indicate that irradiation studies of hydrocarbon vapors must be conducted at very low conversion if meaningful results are to be obtained. The difference in radiolysis behavior is a simple difference in radiation quality. Consequently, the difference between electron and γ radiolysis lies in radiation intensity and distribution. The results show that electrons from a Van de Graaff are initially monoenergetic while those from Co^{60} have a broad distribution of energies. (N.W.R.)

12972 REACTIONS OF TRITIUM ATOMS WITH FROZEN HYDROCARBONS. R. D. Shores and H. C. Moser (Kansas State Univ., Manhattan). J. Phys. Chem., 65: 570-1(Mar. 1961).

The reactions of tritium atoms of intermediate energy with frozen hydrocarbons were examined. Hydrocarbons used were cyclohexane, cyclohexene, 1-hexene, n-hexane, and n-pentane. Results show that tritium atoms with unsaturated compounds, both addition and substitution, occurred; with saturated compounds, substitution was the principal reaction. (N.W.R.)

12973 THE EFFECT OF GAMMA RADIATION ON THE STRUCTURE OF PECTIN. AN ELECTROPHORETIC STUDY. E. R. Skinner and Z. I. Kertesz (State Agricultural Experiment Station, Geneva, N. Y.). J. Polymer Sci., 47: 99-109(Nov. 1960).

Citrus pectin irradiated in the dry state with gamma-radiation doses up to 2056 krad was studied by moving boundary electrophoresis in acetate buffer. The results showed that no extra components are produced upon irradiation and that there is no change in the mean mobility of the pectin boundary or in the mobility distribution about the mode. The heterogeneity constant, calculated from the rate of increase of standard deviation of the mobility curve, showed little change at doses up to 205 krad, but at 528 and 2056 krad there was a large increase. The specific viscosity decreased with radiation dosage. These results indicate that the effect of radiation is to produce random hydrolytic fissure of the glycosydic linkages along the length of the pectin molecule. The increase in heterogeneity constant is explained on the basis of the fragments having slightly wider distribution in charge to mass ratio according to the location of the fissure in relation to the free carboxyl groups. The hydrolytic fissure results in a lower weight-average molecular weight of which specific viscosity is a function. This process also results in a wider distribution of the charge to mass ratio, proportional to the heterogeneity constant. That the two measurements are related is shown by the fact that their product is approximately constant. The constancy of the mobility of the pectin boundary and the lack of any gross change in the electrophoretic properties precludes the occurrence of changes such as deesterification which would alter the charge on the pectin molecule. (auth)

12974 IRRADIATION EFFECTS IN LEXAN. R. E. Barker, Jr. and W. G. Moulton (Univ. of Alabama, University). J. Polymer Sci., 47: 175-91(Nov. 1960).

The destruction of free radicals by oxygen diffusion into x-irradiated Lexan, $[-O-C_6H_4-(CH_3-C-CH_3)-C_6H_4-O-(C=O)-]_n$, was studied by means of optical and electron paramagnetic resonance measurements. Lexan, which is normally amber, appears uniformly green immediately after x irradiation but in a few hours begins to bleach from the edges toward the interior, and a visible amber border forms about a green core. By direct measurements of the rate of recession of the boundary, it was found that the phenomenon is due to O_2 diffusion and that the process obeys an Arrhenius expression (between 0 and 130°C) with an activation energy of 0.31 ev (±3%). It is shown that Zener's equation for the diffusion "frequency factor," $D_0 = \gamma s^2 \nu \exp\{\Delta BE/kT_m\}$, is useful in the study of diffusion in polymers even though it was derived for the case of atomic diffusion in metallic crystals. In the spectral region studied (0.3 to 0.7 μ) there are two bands (near 0.40 and 0.34 μ) present in the irradiated polymer which are not present in the unirradiated material. The center producing the absorption at 0.34 μ is stable over a long period. The absorption at 0.40 μ decays in a few days at room temperature when oxygen is present. At 250 and 9000 Mc there was a single EPR absorption with a width of 13 ± 3 gauss, and at 250 Mc, a g value of 2.012 ± 0.007. Measurements of changes in the spin concentrations with irradiation dose and sample age (measured from the instant of removal from the x rays) showed that the color center which absorbs near 0.40 μ is paramagnetic. The radiation G value (at 40 kv and 18 kr/min.) for the paramagnetic centers was estimated to be about 5 spins/100 ev by comparison of the Lexan EPR spectrum with that of a DPPH spin standard. A simplified rate equation which was consistent with the decay data may be written: $\dot{n} = K'n/t^{\alpha}$, where n is the average spin concentration as a function of time t and $\alpha \simeq \frac{1}{2}$. The $t^{-\alpha}$ factor can be interpreted in terms of a diffusion-limited supply of oxygen in the interior of irradiated Lexan. (auth)

12975 RADIOLYSIS OF POLYMETHYL ISOPROPENYL KETONE. Allan R. Schultz (Minnesota Mining and Mfg. Co., St. Paul). J. Polymer Sci., 47: 267-76(Nov. 1960).

Polymethyl isopropenyl ketone (PMIPK) undergoes random chain scission when irradiated at 23°C with γ rays or with ultraviolet light. Total energy absorption per chain scission, E_d, is 94 ev/scission for PMIPK powders irradiated in vacuo with spent reactor fuel element gamma rays (0.42 Mrad/hr). E_d is 84 ev/scission for a PMIPK powder irradiated in vacuo with Co^{60} γ rays (0.109 Mrad/hr). The presence of air lowers the value of E_d to 41 ev/scission under the former conditions. A film of PMIPK irradiated in air with 2537-A wavelength light exhibits $E_d = 22$ ev/scission or a quantum yield $\phi_d = 0.22$ chain scissions/absorbed photon. The viscosity-average molecular weights of this film vary with light exposure in accordance with theoretical predictions. (auth)

12976 ON THE ESR SINGLET SPECTRA FREQUENTLY OBSERVED IN IRRADIATED POLYMERS AT A LARGE DOSE. Shun-Ichi Ohnishi, Yuichi Ikeda, Shun-Ichi Sugimoto, and Isamu Nitta (Osaka Labs.). J. Polymer Sci., 47: 503-7 (Nov. 1960).

A large number of polymers were found to give singlet ESR spectra when highly irradiated or heated after irradiation. Such polymers are polyethylene, polypropylene, polyvinyl chloride, rubber, polymethyl methacrylate, polyvinyl alcohol, and β-carotene. The singlet spectra are quite similar to each other with a ΔH_{ms1} value of ~17 gauss and are interpreted in terms of an unpaired electron in a conjugated double-bond system, $-CH_2-\dot{C}H-(-CH=CH-)_n-CH_2-$. If n = 0, the unpaired electron localizes on the central carbon and a sextet spectrum results; whereas for large n, a singlet spectrum may result. It is tentatively concluded that irradiation produces double bonds in carbon chain polymers and extends the conjugation region of the double bonds with dose to an 11 double-bond limit as in β-carotene. (D.L.C.)

12977 CONCENTRATION OF RADIOACTIVE PHOSPHORUS, P^{32}, IN THE CARRIER-FREE STATE BY ADSORPTION ON IGNITED BARIUM SULPHATE. K. R. Kar and M. M. Bhutani (Delhi Univ.). J. Sci. Ind. Research (India), 20B: No. 2, 53-8(Feb. 1961). (In English)

A new method for the concentration of radioactive P^{32} in the carrier-free state is developed, with ignited barium sulfate as the carrier. In the first step the radioactive phosphate is carried, under optimum conditions, from its aqueous solution on ~0.3 g of ignited barium sulfate; the adsorbed activity is subsequently desorbed by minimal amounts of 0.1N hydrochloric acid. The sample is finally freed from traces of cationic impurities. The separation is tried in the presence as well as absence of certain cations, e.g., Cu^{2+}, Zn^{2+} and Cd^{2+}. The over-all recovery of the activity is ~95% of the initial activity. The working conditions for the carrier-free separation of the radioactivity are examined thoroughly. (auth)

12978 DESIGN AND OPERATION OF THE RADIOCHEMISTRY LABORATORY. PART II. G. R. Hall (Imperial Coll., London). Nuclear Energy, 111-13(Mar. 1961).

The problems of providing adequate ventilation and effluent control in radiochemical laboratories are discussed. The calculation of air changes for a particular laboratory setup and fumehood design are considered. Extraction filtration must be used for the air from class A and B laboratories, and the air should be released to the atmosphere at or above roof level. For effluent control in a class A laboratory, all drainage is usually fed to delay tanks which can be monitored prior to disposal or treatment. The disposal of radioactive solid wastes and the more highly radioactive liquid wastes is also discussed. The storage of active sources and materials is briefly considered; rooms for such storage should be ventilated. Various laboratory materials are discussed, e.g., floor covering, walls, sinks, furniture, and fumehoods. Finally, the problems of laboratory management are discussed, and some safety precautions and a possible procedure for use in case of accidents involving radioactive materials are given. It is strongly recommended that the designer and scientist meet at the earliest possible stage in the design of the radiochemical laboratory. (D.L.C.)

12979 ON THE IONIZATION OF MOLECULAR GASES BY BETA PARTICLES. Włodzimierz Kołos (Inst. of Nuclear Research, Warsaw and Inst. of Physical Chemistry, Warsaw). Nukleonika, 5: 719-26(1960). (In English)

Qualitative results were obtained which show that the average energy required to produce an ion pair by β particles should be greater for diatomic gases than for those composed of free atoms. The hydrogen molecule was used as an example, and the results obtained account for the discrepancy between the theoretical values of the energy for free atoms and the experimental ones for the molecule. (auth)

12980 THE RADIATION CHEMISTRY OF CHLOROFORM. Michael Ottolenghi and Gabriel Stein (Hebrew Univ., Jerusalem). Radiation Research, 14: 281-90(Mar. 1961).

An attempt was made to investigate the radiation chemistry of pure, oxygen- and water-free chloroform and to identify and quantitatively determine all the products. Irradiations were carried out with x rays at a dose rate of 3.7×10^{18} ev ml^{-1} hr^{-1} in a helium atmosphere. The only products formed were HCl, CH_2Cl_2, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, pentachloroethane, hexachloroethane, and tetrachloroethylene. The G values of formation for all these products were determined, as well as its dependence on total dose. A mechanism was derived which accounts for the experimental facts and is based on the known bond energies. The use of the biallyl-chloroform system as a dosimeter is described. (M.C.G.)

12981 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF COATED POLYMERIC SUBSTRATES. (to E. I. du Pont de Nemours and Co.). British Patent 856,329. Dec. 14, 1960.

A method is presented for manufacturing coatings of graft polymers on polymeric substrates. In this method, the substrate is irradiated with at least 0.01 watt-sec/cm^2 substrate surface of ionizing radiation in the presence of not more than 10^{13} to 5×10^{16} molecules O_2/cm^2 surface, subsequently stored (if desired), and then contacted with the desired unsaturated monomer in the absence of additional O_2. Examples of the method are given in which 66 nylon and polyethylene terephthalate are coated with methyl acrylate. (D.L.C.)

12982 RADIOALKYLATION OF NORMAL PARAFFINS. (to Esso Research and Engineering Co.). British Patent 858,073. Jan. 4, 1961.

A method for producing saturated branched-chain hydrocarbons is given in which a straight-chain hydrocarbon is reacted with a mono-olefin in the presence of a Friedel-Crafts catalyst and high-energy ionizing radiation. A 3:1 to 100:1 mixture of a normal paraffin having 4 to 12 carbon atoms and a mono-olefin having 3 to 12 carbon atoms in contact with $AlCl_3$ (10 to 250 wt.% based on the paraffin weight) is exposed to radiation until 10^{-6} to 10^5

kw-hr energy is absorbed per pound of hydrocarbon. The products are usually liquid, saturated branched-chain hydrocarbons boiling in the range 85 to 440°F and useful for upgrading refinery gases and light virgin naphtha to high-octane gasoline components. (D.L.C.)

12983 IMPROVEMENTS IN RADIOCHEMICAL POLYMERIZATION PROCESSES. (to Nobel-Bozel). British Patent 860,244. Feb. 1, 1961.

A method is given for preparing cellulose-base copolymers in the form of polymerized powder compositions for use in molding processes. In this method, a mixture of at least one cellulose derivative and at least one polymerizable monomer is exposed to ionizing radiations. A mechanical conditioning step may be used prior to irradiation to remove the occluded air from the mixture. Conventional additives, e.g., plasticizer, may be used to modify the characteristics of the resulting copolymer compositions. Several examples of the method are given. (D.L.C.)

12984 IMPROVEMENTS IN OR RELATING TO THE MODIFICATION OF SYNTHETIC POLYMERS. (to E. I. Du Pont de Nemours and Co.). British Patent 860,408. Feb. 1, 1961.

A process for modifying a solid synthetic polymer is given in which the polymer is irradiated with high-energy particles in the presence of tetrafluoroethylene, hexafluoropropene, or perfluorocyclobutene. In this way, crosslinking is produced in the polymer at a rate faster than in the absence of the monomer. The polymers which may be treated in this way include linear polyamides, polyvinylidene halides, polyvinyl acetals, halogenated and halosulfonated alkene-1 polymers, and vinyl compound polymers. (D.L.C.)

Raw Materials and Feed Materials

12985 (MCW-1463) PROCESS DEVELOPMENT QUARTERLY PROGRESS REPORT, OCTOBER–DECEMBER 1960. (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Feb. 1, 1961. Contract W-14-108-eng-8. 99p.

Work was continued on fluid-bed denitration, flame denitration, pilot-plant fluid-bed reduction, pilot-plant fluid-bed hydrofluorination, and the determination and use of diffusion coefficients for hydrogen in uranium. A surface-active agent was introduced into the refinery solvent by a uranium concentrate. The agent caused reduced capacity and efficiency in the re-extraction pulse columns. Studies of the fluid-bed-denitrator operating variables continued. Sulfating agent, fluidizing medium, and spray nozzle design and operation were varied, and their effect on particle-size distribution was studied. The flame denitrator is capable of sustained operation with a product assay of 80% UO_2 or better. An experimental program in the pilot-plant reduction fluid bed showed the effect of bed temperature, feed rate, and gas excess on the degree of conversion. The sustained production of dingot-grade green salt was demonstrated in the pilot-plant two-stage hydrofluorinator, using anhydrous HF. Partially reduced UO_2 from the pilot-plant flame denitrator was processed in a production-scale stirred-bed reduction-hydrofluorination reactor at low rates. No powder flow difficulties were experienced. Although reduction was not complete and UO_2F_2 appeared in the product, no unconverted UO_2 was found. The ability and capability to α-extrude hollow-cast ingot billets to thin-walled tubes for the Mark V-B outer-core fuel element, using the Weldon Spring facilities, was demonstrated. The extrusion of a test quantity of HAPO C-VI-N cores from γ-extruded dingot-uranium billets was completed. High-quality tubes and very satisfactory yields were obtained. More accurate diffusion coefficients for hydrogen in uranium in the α, β, and γ phases are reported. Abnormal hydrogen transfer in high-hydrogen cores during plant outgassing is attributed to the presence of uranium hydride. The feasibility of controlled hydrogen removal from dingot-uranium core blanks by vacuum outgassing in the α temperature range was demonstrated in plant practice. Reproducible results were obtained. The effect of thermal treatment in the high-α temperature range on the structure of β-treated dingot uranium was investigated. Time-temperature curves were prepared for both hollow and solid core geometries, and cores with complete refinement of grain size were produced. (For preceding period see MCW-1459.) (auth)

12986 (MITG-422) PROGRESS REPORT ON RAND ORES FOR APRIL 16, 1950–MAY 15, 1950. John Dasher (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). May 15, 1950. Decl. Feb. 1, 1961. Contract W-7405-eng-85. 9p.

Cyclic tests with a single resin column gave excellent results with single-leach processes. Copper precipitation was tested cyclically. A cyclic test on the pyrophosphate precipitation process was run using a radioactive phosphorus. (auth)

12987 (NP-9866) RESEARCH AND DEVELOPMENT QUARTERLY REPORT [FOR] OCTOBER–DECEMBER, 1960. (Eldorado Mining and Refining Ltd. Research and Development Div., Ottawa). 13p. (R 60-4)

In the solvent-in-pulp program continuous and batch tests were carried out with good uranium extraction results but excessive amine losses. Work on turbine type mixing was discontinued for the present in favor of a different approach to the problem of slurry-solvent contact. In the work on electrolytic reduction, uranous sulfate solubility data were obtained in various salt systems to determine means of preventing precipitation in the electrolytic cell. A rotating disk mercury cathode cell was constructed. (auth)

12988 PROCESS OF PRODUCING URANIUM. T. K. Wood. U. S. Patent 2,977,220. Mar. 28, 1961.

A process is described for the production of uranium in massive form. It consists of heating to reaction temperature in an open container, deep in comparison with its cross section, a mixture consisting of substantially anhydrous uranium tetrafluoride in finely divided form and calcium, characterized in that the calcium is in the form of small plate-like pieces of thickness between $\frac{1}{32}$ and $\frac{1}{80}$ in. The packing density is such that the free space between the pieces of calcium is substantially equal to the volume of the uranium tetrafluoride.

12989 METHOD AND APPARATUS FOR CALCINING SALT SOLUTIONS. Stephen Lawroski, Albert A. Jonke, and Rollin G. Taecker (to U. S. Atomic Energy Commission). U. S. Patent 2,981,592.

A method is given for converting uranyl nitrate solution into solid UO_3. The solution is sprayed horizontally into a fluidized bed of UO_3 particles at 310 to 350°C by a nozzle of the coaxial air jet type at about 26 psig. Under these conditions the desired conversion takes place, and caking in the bed is avoided.

Separation Processes

12990 (AERE-R-3508) CAPACITY, CONTROL AND "TBP STEAM STRIPPING" TRIALS ON A SMALL EVAPORATOR. B. T. Bell and S. S. Grimley (United Kingdom

Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1960. 27p.

Declassified Version of AERE CE/R-1305.

Trials are reported on an experimental evaporator designed to reduce the volume three or fourfold and remove 99.9% of the dissolved TBP from a typical plutonium aqueous product stream in a continuous solvent extraction process. The capacity of the evaporator was found to be sufficient to enable a 3 to 1 evaporation to be carried out. Density, pressure drop, and boiling-point rise methods of automatic control were studied, and the pressure drop method was found to be the most practicable for the conditions studied. Spray carry-over, TBP stripping, and iron pick-up methods were all investigated and found to be satisfactory. (auth)

12991 (ANL-6223) PURIFICATION OF REACTOR FUELS USING LIQUID ZINC. J. B. Knighton, L. Burris, Jr., and H. M. Feder (Argonne National Lab., Ill.). Jan. 1961. Contract W-31-109-eng-38. 35p.

The possibilities of purification of reactor fuel materials by processing in liquid zinc media were studied. Information was accumulated on solubilities of uranium, zirconium, ruthenium, palladium, barium, cerium, and molybdenum in liquid zinc as a function of temperature. Additional information on solubilities of ruthenium, zirconium, barium, and cerium in uranium-saturated zinc solutions was obtained along with data on the behavior of individual elements in complex zinc solutions resulting from solution in zinc of fissium alloys. The effects of magnesium addition to zinc solutions were examined, and several of the engineering operations required for fullscale development were demonstrated. Some chemical reactions in liquid zinc media were briefly explored. (auth)

12992 (CF-60-11-126) CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION C PROGRESS REPORT FOR OCTOBER–NOVEMBER 1960. K. B. Brown (Oak Ridge National Lab., Tenn.). Mar. 3, 1961. 51p.

Studies are being made on the recovery of thorium (and uranium) from granitic rock. In preliminary leaching studies on 16 granite samples (containing 8 to 95 ppm thorium and 1.5 to 16 ppm uranium), maximum recoveries of thorium and uranium ranged from 30 to 85% and 15 to 65%, respectively, and sulfuric acid consumption was high (30 to 120 lbs H_2SO_4 per ton of granite). A relatively high acidity was needed to obtain rapid and efficient dissolution of the soluble thorium fraction. Estimated costs per pound of thorium plus uranium recovered ranged from $30 to 500. U/FP separation factors, previously observed to increase with decreasing TBP concentrations in Amsco 125-82, were found to increase more markedly with TBP in Solvesso-100 and DSBPP in Solvesso-100, at least from 1.35M down to 0.7M. The alkaline permanganate and the alkaline alumina solvent treatment methods were compared in their ability to clean up at 1M TBP solution in Amsco 125-82 which was exposed to radiation in the presence of nitric acid and scrubbed with sodium carbonate to remove low molecular weight acids. Both solids, the alumina and the manganese dioxide formed during treatment, showed similar sorption patterns for the remaining degradation products. Impurities causing 50 to 60% of the Zr–Nb extraction power of the degraded solvent were easily sorbed whereas removal of another fraction causing 20 to 25% of the extraction required further relatively large additions of solid. Even at the highest solids levels used, the solvent retained 20 to 25% of its extraction power. Cleanup equivalent to that obtained with alumina was achieved with ~20 times less manganese dioxide. The proposed three-cycle process for extraction of strontium and rare earths from Purex waste using di(2-ethylhexyl)-phosphoric acid (D2EHPA) was run with nonradioactive solutions in miniature mixer-settler equipment in order to test equipment and chemical flowsheet prior to hot cell experiments that will use high activity level Purex waste as feed. A preliminary study of the diffusion of uranium in acidic aqueous sulfate solutions indicated that the diffusivity of the uranyl ion is about ten times that of either the monosulfate complex or the disulfate complex, in reasonable agreement with the factor of six derived from measurements of the extraction kinetics with similar aqueous systems. (auth)

12993 (DP-548) DI-2-AMYL 2-BUTYLPHOSPHONATE AS AN EXTRACTANT FOR THE RECOVERY OF URANIUM AND PLUTONIUM. Thomas H. Siddall, III. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Feb. 1961. Contract AT(07-2)-1. 16p.

Equilibrium data are presented for the extraction of uranium, nitric acid, zirconium, and plutonium(IV) from aqueous solutions of nitric acid by 1.096M di-2-amyl 2-butylphosphonate (DABP) in n-dodecane. Preparative methods for DABP are discussed. (auth)

12994 (HW-65979) THE ZIRFLEX PROCESS TERMINAL DEVELOPMENT REPORT. P. W. Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 20, 1960. Contract AT(45-1)-1350. 51p.

The Zirflex Process employs a boiling aqueous solution of ammonium fluoride and ammonium nitrate to dissolve zirconium or Zircaloy. Average unoxidized Zircaloy dissolution rates are from 10 to 15 mils/hr for the optimum charge solution of 5.5M NH_4F–0.5M NH_4NO_3 at a F/Zr mole ratio of 7. Zircaloy, which is oxidized by exposure to high-temperature air or water, dissolves at rates of three- to five-fold less. Cores of uranium, uranium-aluminum, and uranium dioxide are not severely attacked by the Zirflex decladding solutions. Only the soluble uranium enters the waste, with losses varying from 0.3 to 3.0 g/l. The Zirflex waste solution is neutralized to a pH of 10 before storage. This requires approximately 0.07 gallon of 50% caustic per gallon of decladding solution. The neutralized waste consists of nearly 20 vol.% of rapidly settling solids, which are easily slurried under turbulent flow conditions. These solids tend to settle out in streamline flow and therefore agitation is required during temporary storage. Conventional nitric acid core dissolution is generally applicable to Zircaloy-clad uranium and UO_2 elements since the core material is essentially free from zirconium. The addition of aluminum nitrate to the nitric acid dissolvent at an aluminum/residual F^- mole ratio of approximately three is necessary, however, to inhibit the corrosive action of residual fluoride. Stainless steel can be used as the material of construction for the Zirflex dissolver equipment because of the dissolvent's comparatively mild corrosive action. A corrosion rate of 11 mils/month was determined using 304L stainless steel exposed to boiling 6M ammonium fluoride. (auth)

12995 (IDO-14534) CHEMICAL PROCESSING TECHNOLOGY QUARTERLY PROGRESS REPORT, APRIL-JUNE 1960. J. R. Bower, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Nov. 10, 1960. Contract AT(10-1)-205. 87p.

Zirconium type fuel from the Nautilus and the NRF prototype cores was processed using improved flowsheets, based on hydrofluoric acid dissolution, which approximately

doubled the original design capacity and achieved 99.43% recovery of uranium while producing approximately 20% less waste volume than the previous flowsheet. Dissolution of ceramic fuels in molten ammonium bifluoride was found to be quite slow, even at the boiling point of the reagent. General aqueous processing studies demonstrated the practicality of air sparge mixing of solutions in large vessels filled with Raschig rings. The production of two phase forms of alumina, α and amorphous, at apparently the same process conditions was found in a NaK-heated calciner. Corrosion studies were made of Inconel and Inconel-X at the 1200 to 1500°F temperatures expected in the high-temperature storage facility for calcined wastes. The feasibility of calcining fluoride-containing wastes in stainless-steel equipment was investigated. Preparation of standard operating procedures and test programs for process evaluation of a Demonstrational Fluidized Bed Calcining Facility was continued. In a study of new waste treatment methods it was found that during electrolysis of stainless-steel wastes, using a mercury cathode, zirconium was co-removed with the stainless-steel components while strontium and niobium were retained in the aqueous solution. It was determined that the use of approximately 2.8 g of ammonium phosphomolybdate would remove essentially all of the cesium from one liter of first-cycle aluminum nitrate waste. Favorable corrosion results indicated the possibility of blending and storing raffinate wastes in type 347 stainless-steel tanks. Factors affecting the electrical contact of fuel pieces in an electrolytic dissolver were investigated during the electrolytic dissolution of stainless steel in nitric acid. Basic electrochemical data are reported for the electrolytic dissolution of zirconium in HCl–methanol. An extension of the ARCO process to stainless-steel-, chromium-, and niobium-based fuels is discussed. Fission product concentrations and activities were calculated for Dresden fuels. (M.C.G.)

12996 (IDO-14535) REVIEW OF RESEARCH AND DEVELOPMENT AT THE IDAHO CHEMICAL PROCESSING PLANT ON THE ELECTROLYTIC DISSOLUTION OF NUCLEAR FUEL. C. M. Slansky, K. L. Rohde, and H. T. Hahn (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Jan. 19, 1961. Contract AT(10-1)-205. 57p.

A review of work on a universally applicable electrolytic nuclear fuel dissolution process is presented. Flowsheets were developed for Army Package Power Reactor fuel recovery and continuous dissolution was obtained for stainless steel, Nichrome, and Illium-R. Other investigations resulted in recommendations for selection of materials for process equipment, design of cells, application of electrolytic techniques for cutting stainless-steel tubing, and decladding of uranium dioxide. (J.R.D.)

12997 (MITG-420) PROGRESS REPORT ON RAND ORES FOR [PERIOD] FEBRUARY 16, 1950–MARCH 15, 1950. John Dasher (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Mar. 15, 1950. Decl. Feb. 1, 1961. Contract W-7405-Eng-85. 11p.

The use of anion-exchange resins for selective uranium recovery from Rand leach liquors on a pilot-plant scale is discussed. Cyclic, locked-batch testing of other methods of producing a high-grade product was terminated. It was found that carbonate leach solutions precipitated by lime can be partly regenerated with CO_2 for reuse. The uranous phosphates thus far obtained were colloidal and of variable composition. (auth)

12998 (NAA-SR-Memo-1558) ELECTROREFINING OF METALS IN FUSED SALTS. Rex A. Barney (North American Aviation, Inc., [Downey, Calif.]). Jan. 13, 1956. 10p.

General methods of electrorefining of reactor fuels are presented and briefly compared with other pyroprocesses. A distinctive feature of electro-refining is the ability to separate more noble fission elements such as ruthenium, niobium, and zirconium from irradiated uranium. Use of alloying metals to form a dripping cathode and consequent use of lower temperature baths is discussed. The method appears desirable for processing thorium fuels since melting of thorium is not necessary. This would obviate temperature and container problems. (auth)

12999 (NAA-SR-Memo-1791) RESEARCH IN THE SEPARATIONS CHEMISTRY OF OXIDE SLAGGING AND ELECTROREFINING OF URANIUM. A. G. Buyers, R. A. Barney, W. N. Hansen, W. E. McKee, E. W. Murbach, and T. Smith (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 27, 1956. 14p.

A proposal is made for a detailed study of the high-temperature chemistry of oxide slagging and electrorefining of uranium. It is suggested that this study concerning fission products and fissionable elements include identification of molecular species slagged by UO_2; measurement of equilibrium values, Ke, $\Delta F°$ (reaction); and the chemical mechanism of slagging reactions. The electrorefining investigation should encompass an evaluation of temperature effects, cathode alloys, and anode sludge composition. (auth)

13000 (AEC-tr-4517) ION EXCHANGE EQUILIBRIA OF URANYL SULFATE ION WITH CHLORIDE–SULFATE OR NITRATE–SULFATE MIXED FORM OF STRONGLY BASIC ANION RESINS. Takeo Yano, Takeshi Kataoka, and Teruyuki Nango. Translated from J. At. Energy Soc. Japan, 2: 511-17(1960). 24p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 1465.

13001 (AEC-tr-4549) PROCESSING OF IRRADIATED URANIUM BY SUBLIMATION OF THE CHLORIDES. P. Speeckaert (Brussels. Centre d'Étude de l'Énergie Nucléaire). Translation of Report BLG-38. July 13, 1959. 16p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 6318.

13002 (JPRS-6867) SORPTIVE EXTRACTION OF URANIUM FROM PULP AND SOLUTIONS. B. N. Laskorin. Translated from Atomnaya Energ., 9: 286-96(1960). 26p.

The basic patterns of ion-exchange processing of uranium ores are described. The effectiveness of various cationic and anionic ion-exchange materials for uranium sorption is discussed, and the effects of various additives on uranium sorption from solution are shown graphically. A table is given containing a comparative evaluation of anionic exchangers used in different countries. The theory of uranium sorption from purified solutions is treated, and sorption from ore pulps is considered. A flowsheet is included for the preparation of U_3O_8 from ore via pulp. (D.L.C.)

13003 (UCRL-Trans-537(L)) ION-EXCHANGE SEPARATION OF RARE-EARTH ELEMENT ACTIVITIES WITHOUT THE USE OF A pH-METER. B. L. Preobrazhenskii, O. M. Lilova, A. N. Dobronravova, and E. D. Teterin. Translated by Esther Goldberg from Zhur. Neorg. Khim. 1: 2294-9(1956). 9p.

A method is described for separation of quantities of rare-earth elements in ion-exchange resins with prepared complex-forming washout agents without the use of a pH meter. The procedure was used in small-sized columns,

and radiochemical separations were achieved in about 3 hr. (J.R.D.)

13004 APPLICATION OF THE DOUBLE WITHDRAWAL COUNTERCURRENT EXTRACTION TECHNIQUE TO ANALYTICAL CHEMISTRY. James O. Hibbits (General Electric Co., Cincinnati). Anal. Chim. Acta, 24: 113-20(Feb. 1961). (In English)

Application of the double withdrawal countercurrent extraction technique to chemical analysis was previously neglected, probably because of the complexity and tediousness of the associated mathematics. Present day computer technology proved to be readily applicable to the problem, and information is presented which indicates the possible importance of this separation method to chemical analysis. (auth)

13005 ION EXCHANGE SEPARATION OF RUBIDIUM AND CESIUM. (CHEMICAL STUDIES ON RADIOACTIVE INDICATORS. XXIII). Masayoshi Ishibashi, Taitiro Fujinaga, Mutsuo Koyama, and Taiji Naito (Kyoto Univ.). Bunseki Kagaku, 10: 116-19(Feb. 1961). (In Japanese)

Ion exchange separation of Rb and Cs was investigated by the batch and the column methods using Rb^{86} and Cs^{137} as indicators. Dowex 50-X8 (200 to 400 mesh) was used as the exchange resin and HCl solutions were employed for the eluant. From the values of both elements determined by the batch method, it was shown that the lower concentration of the eluant would give the more effective separation. By the column method, elution curves for each element were taken automatically using a recording rate meter. The effects of the amounts of the salts in question and of the concentration of HCl to the elution curves were examined. From the results of the foregoing experiments, Cs and Rb from trace quantities to 0.058 m mole could be separated using 0.5N HCl as the eluant with the column of 25.5 cm × ϕ 0.6 cm. Effects of Na, K, and NH_3 on the elution curve of carrier free Cs^{137} were investigated and the separation of them from Cs^{137} was made. (auth)

13006 COMPARISON OF DESIGN AND OPERATING PERFORMANCE AT THE I.C.P.P. A. L. Ayers and F. Morgan Warzel (Phillips Petroleum Co., Idaho Falls, Idaho). Chem. Eng. Progr., 56: Symposium Ser. No. 28, 1-11(1960).

Design criteria are presented and compared to operating performance for several types of equipment used in a direct maintenance nuclear-fuel reprocessing plant. (auth)

13007 VOLATILITY PROCESSING OF THE ARE FUEL. William H. Carr (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr., 56: Symposium Ser. No. 28, 57-61(1960). (OR-9811-60)

The highly enriched uranium used in the Aircraft Reactor Experiment is recovered in the Volatility Pilot Plant at Oak Ridge National Laboratory—the first complete reactor charge reprocessing by a nonaqueous technique. The fuel is a combination of fluoride salts, including uranium tetrafluoride, with a melting point of 525°C. The direct fluorination process used is based on the volatility and absorption characteristics of uranium hexafluoride. A second complete reactor charge is also reprocessed, with 99% of the uranium recovered as uranium hexafluoride and most of the remainder in aqueous solution. Losses in the processing of this second reactor charge are approximately 0.01%. The decontamination factor is about 10^4, the highest that can be demonstrated with the activity levels used. There is no detectable fission-product activity in the uranium hexafluoride product, the total activity being what would be expected from the uranium alone. The equipment is fairly small—for example, the fluorinator capacity is about 50 liters—but 10 kg. of uranium can be processed in each run. During ARE processing, two runs are made per week with two operators and a supervisor on each shift. (auth)

13008 DEVELOPMENT OF PROCESSING METHODS FOR THE URANYL SULFATE BLANKET SOLUTION OF A HOMOGENEOUS REACTOR. J. M. Chilton and R. E. Leuze (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr., 56: Symposium Ser. No. 28, 62-5(1960). (OR-58-7-103(Rev.))

Plutonium in 1.4M UO_2SO_4 at 250°C is readily hydrolyzed to crystalline PuO_2, leaving approximately 3.7 mg/kg H_2O in solution. This suggests that plutonium produced in a homogeneous reactor can be concentrated by means of a solid-liquid hydroclone into a small volume of reactor solution and removed for chemical processing. Experiments at simulated reactor conditions show that PuO_2 reaching the hydroclone is concentrated but that most of the plutonium is adsorbed on, and found within, the corrosion film of the equipment and thus never reaches the hydroclone. Plutonium adsorption can be greatly decreased if it does not hydrolyze and precipitate. For this reason, it may be advisable to add 0.4M H_2SO_4 to increase plutonium solubility to >100 mg/kg H_2O and to develop methods for removing soluble plutonium. Plutonium solubility, valence state, and adsorption are investigated at simulated reactor conditions in static laboratory experiments and in a 13-liter-capacity circulating loop. (auth)

13009 RESEARCH ON LOW-GRADE URANIUM ORE TREATMENT BY GASEOUS CHLORINE IN THE PRESENCE OF REDUCING AGENTS. T. Adamski and J. Zienkiewicz (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 761-9(1960). (In Russian)

Basic principles, methodology, and results of research work on the chlorination of uranium-containing materials are presented. High extraction coefficients, as well as valuable by-products, for example anhydrous aluminum chloride, were obtained. Reactions of the by-products with the ore were studied. Pure uranium, calcium, and iron oxides were chlorinated to elucidate the complex features of ore chlorination process. The possibility of chlorine economy was proved. It was found that the chlorination method presents a way for a complex uranium ore utilization as also a general way of low-grade ore processing. (auth)

13010 PROGRESS IN NUCLEAR ENERGY. SERIES III. PROCESS CHEMISTRY. VOLUME 3. F. R. Bruce, J. M. Fletcher, and H. H. Hyman, eds. New York, Pergamon Press, 1961. 480p. $15.00.

Some of the papers presented at the second Geneva conference are collected here. They are grouped under 5 headings: Recovery of Uranium Ores, Uranium Refining and the Production of Intermediate and Feed Materials, Irradiated Fuels—Aqueous Procedures, Nonaqueous Processing, and Waste Processing. A final section summarizing all the conference papers related to this general subject is included. (T.R.H.)

13011 IMPROVEMENTS IN OR RELATING TO THE PROCESSING OF URANIUM CARBIDE. Kenneth Hartley and George MacLennan (to United Kingdom Atomic Energy Authority). British Patent 858,970. Jan. 18, 1961.

The usual procedure for processing irradiated uranium carbide for uranium recovery, which consist of dissolution of UC in HNO_3 and solvent extraction, is modified in one important way: irradiated UC is reacted with water at refluxing temperature until acetylene evolution ceases, resulting in a residue of uranium oxides easily dissolved in HNO_3. (D.L.C.)

13012 A PROCESS OF CONCENTRATING THE URANIUM AND/OR PLUTONIUM CONTENT IN AN ALUMINIUM ALLOY, AND APPARATUS THEREFOR. (to U. S. Atomic Energy Commission, Germantown, Md.). British Patent 861,700. Feb. 22, 1961.

A process is given for regenerating aluminum alloys containing plutonium and/or uranium for reuse in reactors. The process consists of making the alloy the anode of an electrolytic cell and contacting the alloy with molten aluminum fluoride-containing material, e.g., cryolite, as the electrolyte, whereby aluminum is removed and an alloy having an increased plutonium and/or uranium concentration is obtained. The cathode can be graphite or aluminum. Three examples of the process are given in which alloys with 0.74 wt.% uranium were enriched to 1.17 and 2 wt.% and an alloy with 1.54 wt.% plutonium was enriched to 1.82 wt.%. (D.L.C.)

13013 IMPROVEMENTS IN METHODS OF CENTRIFUGAL SEPARATION. (to United Kingdom Atomic Energy Authority). British Patent 862,633. Mar. 15, 1961.

A method is given for continuously separating a mixture of gases with molecular weights greater than 250. In this method, the mixture is introduced into a chamber at one end, subjected to centrifugal forces, and withdrawn as heavy and light fractions from the chamber at the other end. Equations are given for the optimum gas flow and the radius of the orifice through which the gas flows. (D.L.C.)

13014 DIRECT CONVERSION OF URANIUM TURNINGS TO URANIUM TETRAFLUORIDE. O. E. Fry. U. S. Patent 2,974,006. Mar. 7, 1961.

A method is given for converting uranium metal turnings directly into uranium tetrafluoride. It consists of cleaning uranium metal turnings, treating the cleaned turnings with a stream of anhydrous hydrogen-free hydrogen fluoride for from 2 to 4 hr at a temperature of between 400 and 600°C, raising the temperature by at least 200°C while continuing the hydrogen fluoride treatment, and maintaining the increased temperature treatment for at least ½ hr.

13015 SOLVENT EXTRACTION PROCESS FOR PROTACTINIUM. Earl K. Hyde, Leonard I. Katzin, and Michael J. Wolf (to U. S. Atomic Energy Commission). U. S. Patent 2,978,294. Apr. 4, 1961.

A process is described for separating protactinium from thorium present together as the nitrates in a 0.1 to 10 N nitric acid solution. The separation is carried out by extraction with an aliphatic alcohol, ketone, and/or ester having at least six carbon atoms, such as n-amyl acetate, 2-ethyl hexanol, and diisopropyl ketone.

13016 RECOVERY OF PLUTONIUM BY CARRIER PRECIPITATION. Robert H. Goeckermann (to U. S. Atomic Energy Commission). U. S. Patent 2,978,295. Apr. 4, 1961.

A process is given for recovering plutonium from an aqueous nitric acid zirconium-containing solution of an acidity between 0.2 and 1 N by adding fluoride anions (1.5 to 5 mg/l) and precipitating the plutonium with an excess of hydrogen peroxide at from 53 to 65°C.

13017 EXTRACTION OF URANIUM. Earl G. Schmieding and Archie E. Ruehle (to U. S. Atomic Energy Commission). U. S. Patent 2,979,379. Apr. 11, 1961.

A method is given for extracting metal values from an aqueous feed wherein the aqueous feed is passed countercurrent to an organic extractant through a plurality of decanting zones and a portion of the mixture contained in each decanting zone is recycled through a mixing zone associated therewith. The improvement consists of passing more solvent from the top of one decanting zone to the bottom of the preceding decanting zone than can rise to the top thereof and recycling that portion of the solvent that does not rise to the top back to the first named decanting zone through its associated mixing zone.

13018 METHOD FOR RECOVERING PLUTONIUM VALUES FROM SOLUTION USING A BISMUTH HYDROXIDE CARRIER PRECIPITATE. B. F. Faris (to U. S. Atomic Energy Commission). U. S. Patent 2,981,591. Apr. 25, 1961.

Carrier precipitation processes for separating plutonium values from aqueous solutions are described. In accordance with the invention a bismuth hydroxide precipitate is formed in the plutonium-containing solution, thereby carrying plutonium values from the solution.

ENGINEERING AND EQUIPMENT

General and Miscellaneous

13019 (ARF-1167-8) FEASIBILITY STUDY OF A NEW MASS FLOW SYSTEM. Period Covered January 1 – January 31, 1961. G. M. Burgwald (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 15, 1961. Contract AT(11-1)-578. 7p.

Machining was completed on the s-tube flow element, and a spring, for use at a constant known temperature, was constructed for the flow element. Calculations for geometry factor, detector efficiency, and effective absorption along the useful radiation path were completed for the reed densitometer. The flow rate control was calibrated and performed satisfactorily. Response to step transient changes occurred with a damping constant of about 0.6 and an effective response time of 10 sec. Sources of error in the s-tube flow rate measurements are discussed. (M.C.G.)

13020 (CF-61-2-38) THERMAL CYCLING TEST OF $3\frac{1}{2}$-IN. AND 4-IN. FREEZE FLANGES. J. C. Moyers (Oak Ridge National Lab., Tenn.). Feb. 2, 1961. 16p.

A total of 104 thermal cycles between 250 and 1350°F were imposed on a $3\frac{1}{2}$-in. and a 4-in. freeze flange to determine their susceptibility to thermal fatigue. The flange clamping arrangement was modified, and various gaskets were used during the cycling in an effort to reduce the gas-leakage problem. No fatigue cracks were detectable after the cycling was completed. However, it was found that the flange faces, which were plane before the test, were conical when the test was finished, indicating the presence of excessive thermal stresses. No consistently leak-tight gas seal was obtained during the test although some improvement over past experience was noted. (auth)

13021 (CF-61-2-84) DETERMINATION OF THE SIX TURBULENT REYNOLDS' STRESSES BY THE HOT WIRE METHOD FOR ARBITRARY TURBULENT INTENSITY AND GEOMETRY WITH SPECIAL APPLICATION TO AXISYMMETRIC FLOW. R. P. Wichner and F. N. Peebles (Oak Ridge National Lab., Tenn.). Feb. 21, 1961. 27p.

A relationship is derived between the mean square fluctuating current of a hot wire anemometer and the six turbulent Reynolds' stresses in the stream-coordinate system without employing the usual low turbulent intensity approximation. The relatively simple result is a consequence of assuming proportionality between the wire current reading and the perpendicular velocity component instead of the nonlinear dependence required by King's law. The assumption is valid for instruments equipped with the proper linearizing circuitry. The stream-coordinate Reynolds' stresses are then related to the cylindrical polar Reynolds' stresses. An error analysis on the experimental determination of one of these stresses is indicated but cannot be evaluated without further data. (auth)

13022 (DLCS-3500401) FEDAL SYSTEM (MULTIPORT VALVE ROTATIONAL TEST). Test Results. Core I, Seed 2. Section 4. (Duquesne Light Co., Shippingport, Penna.). First issue, Jan. 20, 1961. 9p.

Tests were conducted to determine the direction of rotation of the multiport valve in the Failed Element Detection and Location (FEDAL) system. The test equipment and procedures are described. An analysis of the results indicated that the multiport valve was operating in the reverse direction from that indicated by the FEDAL system. (B.O.G.)

13023 (DP-451) DESIGN BASIS FOR PADDLE PUMPS. Donald S. Webster and Clifton L. Williamson (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1960. Contract AT(07-2)-1. 23p.

A design basis for paddle pumps is given. A paddle pump is a simple high-clearance centrifugal pump with a four-bladed flat paddle as an impeller and with no submerged bearings. These pumps have a high dependence of flow on imposed head so that they can be used to transfer liquid between processing units over a wide range of flows without the need of additional adjustment or control devices. Their simplicity and rugged construction are particularly desirable features in radiochemical processing plants. (auth)

13024 (GAMD-1751) PRESSURE: TEMPERATURE AND RELIEF VALVE CONSIDERATIONS FOR THE HTGR REACTOR PRESSURE VESSEL. W. Kalk and M. Kantor (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 8, 1960. Contract AT(04-3)-314. 15p.

Factors pertinent to the structural design, pressure, and temperature for the Peach Bottom Power Reactor pressure vessel are examined. Operating pressures and temperature of helium in the vessel are considered, along with normal and abnormal variations in operating pressure and temperature of the helium. Reactor vessel materials and ASME code rulings are also considered with effects of associated equipment in the system. Reactor vessel overpressure protection is described. (J.R.D.)

13025 (HW-63854) CONFINEMENT AND COLLECTION OF UO_2 FINES FROM A SHEARING OPERATION. G. Rey (General Electric Co. Hanford Atomic Products Operation, Richland Wash.). Oct. 14, 1960. Contract AT(45-1)-1350. 21p.

A test is reported on a critically safe shear system for <5% U^{235} enriched material which is provided with the necessary auxiliaries for confining and collecting dispersed UO_2 fines from a shearing operation. (W.L.H.)

13026 (KAPL-M-EC-3) MSS COMPUTER PROGRAM FOR MOISTURE SEPARATION SCRUBBER PERFORMANCE. J. Jermanok and J. Warrington (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 13, 1961. Contract W-31-109-eng-52. 28p.

MSS is a Philco 2000 digital computer program designed to investigate the moisture separation performance of corrugated plate scrubbers for steam with entrained water droplets. Given the conditions at the entrance, the program describes the path of an individual droplet through the scrubber and determines where the droplet is separated or whether or not it passes through without wall contact. The trajectory of the particle is obtained from two sets of force balance equations for straight and curved sections. These differential equations are integrated numerically. (auth)

13027 (NAA-SR-Memo-1186) CONSTRUCTION AND OPERATION OF A PUMP LOOP FOR ORGANIC MATERIALS. Denis J. Zigrang (North American Aviation, Inc., Downey, Calif.). Dec. 17, 1954. Decl. Nov. 6, 1958. 19p.

A loop was constructed for pumping terphenyl at 900°F at a rate of 10 gpm. Operation of the loop yielded heat-transfer film coefficients that were in surprisingly good agreement with those calculated from the Dittus-Boelter correlation using extrapolated physical-property data. (auth)

13028 (NAA-SR-Memo-3669) LARGE COMPONENTS TEST LOOP SYSTEM TEMPERATURE LIMIT OF ERROR. M. D. Gerber (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 27, 1959. 6p.

Tests were conducted to determine the limit of error of the temperature measuring system for high thermal-stress tests on moderator cans and to determine a means for the calibration of chromel–alumel thermocouples after installation. Results and recommendations are included. (J.R.D.)

13029 (NYO-7875) TEST OF GRANVILLE-PHILLIPS TYPE C ULTRA-HIGH VACUUM VALVE. Technical Memo. No. 33. Herbert Sauer (Princeton Univ., N. J. Project Matterhorn). May 1960. Contract AT(30-1)-1238. 8p.

Tests were made on the ultra-high vacuum valve to determine the feasibility of baking the valve closed at 400°C to enable a copper foil vapor trap to be baked while isolated from its system by the valve. The rate of pressure rise was measured as a function of the valve closing torque between 200 and 400 in. lb, for open and closed bake-outs. The data are tabulated and compared graphically. (B.O.G.)

13030 (NYO-8062) REPRESENTATION OF ELECTRIC SHIELDS AND SHORTED TURNS OF FINITE RESISTANCE ON THE AXIALLY SYMMETRIC MAGNETIC FIELD ANALOG. Technical Memorandum No. 60. Laurence Mead (Princeton Univ., N. J. Project Matterhorn). May 1, 1958. 9p.

A description is presented relative to an extension of magnetic field analog equipment for solution of a class of problems involving fields around conductors of finite resistance inductively coupled to the main confining field. The analysis shows that the resistance of a shield, shorted turn, or plasma can be represented by a capacitance on the analog. Examples of application of the proposed method are included. (J.R.D.)

13031 (SB-410) BEARINGS, 1945–1960. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Apr. 1960. 17p.

This bibliography includes about 300 references arranged in sections for gas-lubricated, journal, roller, friction, antifriction, thrust, sleeve, jewel, and ball bearings. The period covered is 1945 to 1960. (J.R.D.)

13032 (SCTM-381-60(14)) MECHANICAL DESIGN ANALYSIS FOR WHIP-TYPE ANTENNAE. J. W. Allen (Sandia Corp., Albuquerque, N. Mex.). Mar. 1961. 18p.

A mechanical design analysis was made for whip type radio antennas. Equations were derived which facilitated the mechanical design of antennas capable of withstanding a wide range of environmental wind conditions. Graphical solutions to these equations are presented in a generalized manner and are applicable to most structural materials. (auth)

13033 (SCTM-433-60(71)) IMPULSIVE LOADING OF CYLINDRICAL SHELLS. W. B. Murfin (Sandia Corp., Albuquerque, N. Mex.). Feb. 1961. Contract AT(29-1)-789. 32p.

The equations of motion of a thin cylindrical shell are solved for a general impulse load and for a specific loading case. Equations are given for computing membrane and bending stresses. (auth)

13034 (TID-11559) ELASTIC-PLASTIC THERMAL STRESS ANALYSIS OF AN INTERNALLY CLAD TUBE. Bernard W. Shaffer (New York Univ., New York). Aug. 25, 1960. Contracts AF 33(600)-38062 and AT(11-1)-171. 38p. For General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati. Subcontract No. AT 85. (XDC-60-9-42)

Thermal stress and displacement equations are derived for an internally clad tube for which the ratio of cladding thickness to internal tube radius is small with respect to unity and in which the cladding and the basic tube have different material properties. For a prescribed class of temperature functions, plastic flow is found to start in the cladding when the difference between its temperature and the average temperature of the basic tube is large enough. The plastic zone does not propagate into the basic tube even though the temperature of the assembly is increased. The solution is examined in order to select those material properties that would delay the initiation of plastic flow. (auth)

13035 (TID-11905) CYCLIC PRESSURE TESTS OF LARGE SIZE PRESSURE VESSELS. Progress Report No. 26, period covered December 15, 1960–January 15, 1961. M. M. Lemcoe (Southwest Research Inst., San Antonio). Jan. 15, 1961. Contract AT(30-1)-2140. 23p.

An investigation is being made of the plastic fatigue strength of large pressure vessels. The vessels under study have a 36-in. inside diameter, a 2-in. wall thickness, and contain nozzles of several designs and sizes. The overall program includes essentially identical pairs of full-size vessels fabricated from A-201, A-302, and T-1 steels. Fatigue cycling of the second A-201 vessel was completed, and the second A-302 vessel is being prepared for fatique cycling. Static testing of the first A-302 vessel is in progress. (W.L.H.)

13036 (WAPD-BT-21(p.79-88)) AN ANALYSIS OF AVERAGE STRESS INTENSITIES IN STEAM GENERATOR TUBE SHEET LIGAMENTS. W. J. O'Donnell (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

An analysis of stress intensities (shear stresses) in the minimum ligament sections of steam generator tube sheets is presented. This analysis can be used to evaluate the ligament stress intensities based on stresses averaged across the minimum ligament sections at the surface of the tube sheet and stress intensities based on stresses averaged across the minimum ligament sections and averaged through the depth of the tube sheet. Both of these values are limited by the "design basis." The analysis is general and can be used for any biaxiality condition of the stress field in the equivalent solid plate and for any ligament orientation in the stress field; the analytical results are simplified and presented in a form suitable for design calculations. (auth)

13037 (WAPD-BT-21(p.89-97)) THE EFFECT OF THE TUBES ON STRESSES AND DEFLECTIONS IN U-TUBE STEAM GENERATOR TUBE SHEETS. W. J. O'Donnell (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The results of tests run on a steam generator tube sheet are used to evaluate the effect of the rolled-in tubes on stresses and deflections in the perforated portion of the tube sheet. Measured ligament strains are compared with theoretical values calculated for two cases: (1) assuming that the rolled-in tubes contribute no support to the tube sheet and (2) assuming that the entire thickness of the rolled-in tubes is effective in stiffening the tube sheet and reducing ligament strains. Strain values calculated for Case No. 1 are found to average more than 75% higher than those for measured strains, and strain values calculated for Case No. 2 are found to agree with average measured values within about 5%. It is concluded that the tubes con-

tribute substantial support to tube sheets, and this support should be included in design calculations by taking the inside diameter of the as-rolled tubes as the diameter of the perforations. (auth)

13038 THE EFFECT OF MIXER DESIGN ON THE EFFICIENCY OF A PUMP-MIX MIXER-SETTLER. A. T. Davis and T. J. Colven (E. I. du Pont de Nemours and Co., Inc., Aiken, S. C.). A.I.Ch.E. Journal 7: 72-7(Mar. 1961).

The mixing efficiency of simple and pitched paddles, marine propellers, and centrifugal and disk impellers was determined by a heat-transfer method in a single stage of a large pump-mix mixer-settler. The mixing devices were from 3 to 5 in. in diameter and were tested with a refined kerosene as the organic phase and water as the aqueous phase. A heat conductance was calculated from flow parameters and the efficiency and was correlated against impeller design and speed variables. For centrifugal and disk impellers, UA was proportional to $n^{1.2}L^{3}b^{0.3}$; for the paddles, UA was proportional to $n^{1.67}L^{2.5}b^{0.42}$. At normal operating speeds controlled variation of the internal recirculation of mixed phases through a centrifugal impeller did not change the efficiency. (auth)

13039 COLLECTION EFFICIENCIES OF A CASCADE FILTRATION DEVICE EMPLOYING WIRE GAUZES. T. T. Mercer, C. M. Mills, and A. R. Gibb. Ann. Occupational Hyg., 1: 301-13(1960).

Tests to evaluate the performance of a cascade filtration air sampler are described. Gross efficiencies for each filtration stage are given for the collection of uranium dioxide and sodium chloride aerosols at various flow rates. Empirical relationships for collection efficiency as a function of the inertial parameter of a particle are given. (auth)

13040 THE DESIGN AND USE OF A Co^{60} IRRADIATION UNIT IN THE UNITED STATES EXHIBIT, WORLD AGRICULTURAL FAIR. J. L. Brewbaker and M. S. Swaminathan (Brookhaven National Lab., Upton, N. Y. and Agricultural Research Inst., New Delhi, India). Current Sci. (India), 29: 298-301(Aug. 1960). (BNL-4748) (In English)

A Co^{60} irradiation facility was installed and operated in the United States Pavilion at the World Agricultural Fair in New Delhi from December 11, 1959, to March 1, 1960. The unit was designed for the γ irradiation of biological and other research material, as well as for demonstrational purposes, and operated as a service unit to scientists throughout the fair. A description of the unit and discussion of its uses and limitations in agricultural research are presented. (C.H.)

13041 CORROSION-RESISTING VALVES. H. E. Threlfall (Langley Alloys Ltd., Langley, Bucks, Eng.). Nuclear Power 5: No. 53, 100-2(Sept. 1960).

A discussion is presented for corrosion-resistant valves, their design, and materials for their construction. Among the materials discussed are cast iron, cast steel, lead, lead alloys, bronzes, stainless steels, special alloys, plastics, and rare metals. Fluon or Teflon is often used as gland packing, gaskets, and one-half of a valve sealing element (disk or seat facing). The well-known valve designs, including the pinch valve used for corrosive slurries, are tabulated with respect to their general features. The effect of material on the valve design and the problems from two similar materials in contact are discussed. Three other kinds of corrosion also arise: crevice corrosion, electrolytic corrosion between two different materials, and corrosion of one material by corrosion products of another material. (D.L.C.)

13042 IMPROVEMENTS RELATING TO APPARATUS FOR DETECTING LEAKS IN GAS FLOW DUCTS. George Robert Kenneth Jameson (to A. E. I.-John Thompson Nuclear Energy Co. Ltd.). British Patent 859,490. Jan. 25, 1961.

An apparatus is designed for detecting leaks in a gas flow duct. The apparatus comprises a venturi tube mounted in the duct with a restriction on the downstream side of the venturi and a warning means responsive to the ratio of the pressure in the venturi throat to that on the upstream side. The gas flow through the venturi tube is preferably sonic so that the mass flow can vary appreciably without affecting the venturi-upstream pressure ratio. The apparatus is especially useful for detecting leaks in pressurizing machines used in conjunction with a charge-discharge machine in gas-cooled reactors. (D.L.C.)

13043 IMPROVEMENTS IN OR RELATING TO PIPE COUPLINGS. William Paul White (to United Kingdom Atomic Energy Authority). British Patent 862,673. Mar. 15, 1961.

A demountable pipe coupling arrangement is designed which is suitable for operation from remote positions. The coupling consists of a first pipe end, a releasable holder which limits the first pipe in its axial movement and holds it against rotation or releases it for removal, and a second pipe end located in the holder and restrained against rotation but free to move axially. The holder has means to move the second pipe end relative to the first pipe end to make or break a union between the pipe ends. The coupling is suitable for use in pipe lines carrying gases or liquid metals at temperatures up to 300°C and can be carried out remotely from behind radiation shielding. With the pipes in the coupled position, connection can be made by butt welding. (D.L.C.)

13044 IMPROVEMENTS IN OR RELATING TO SAMPLING DEVICES. Arthur James Howarth and Rex William Collins (to United Kingdom Atomic Energy Authority). British Patent 862,680. Mar. 15, 1961.

A sampling device is designed for remote sampling of radioactive liquids and is an extension of the apparatus disclosed in Patent No. 776,617 to permit sampling of liquids at random depths in storage vessels. The device comprises two body members slidably movable relative to each other, with an elastomer-capped sampling bottle fastened to one member and a sampling hypodermic needle fastened to the other member in coaxial alignment with the bottle. The device is lowered into a tank of liquid to the desired depth and then adjusted so that the bottle cap is punctured by the pointed end of the needle and sampling is initiated. After the sampling is completed, the device is raised and the bottle is withdrawn from the needle. (D.L.C.)

13045 CHARGING DEVICE. S. L. Handforth. U. S. Patent 2,975,912. Mar. 21, 1961.

A pivoted arm conveyer apparatus is described which is used to transfer radioactive material from an underwater storage to a barrier-surrounded reaction tank without exposing the material and allows the mechanical equipment to be located in an accessible position outside the barrier.

13046 TWO-SPEED DEVICE. Glenn S. Brunson, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 2,977,814. Apr. 4, 1961.

A two-speed device is described comprising a two-part stop engageable with a follower. The two-part stop comprises first and second members in threaded engagement with each other. The first member is restrained against rotation but is free to move longitudinally, and the second member is free to move axially and rotatively. Means are provided to impart rotation to the second member. The follower is engageable first with an end of one member and

then with the corresponding end of the other member after some relative longitudinal movement of the members with respect to one another due to the rotation of the second member and the holding of the first member against rotation.

Heat Transfer and Fluid Flow

13047 (AFOSR-TN-60-1227) EXAMINATION OF THE SOLUTIONS OF THE NAVIER-STOKES EQUATIONS FOR A CLASS OF THREE-DIMENSIONAL VORTICES. PART I. VELOCITY DISTRIBUTIONS FOR STEADY MOTION. Coleman duP. Donaldson and Roger D. Sullivan (Aeronautical Research Associates of Princeton, Inc., Princeton, N. J.). Oct. 1960. Contract AF 49(638)-255. 118p.

A study was made of the class of solutions of the Navier-Stokes equations wherein the radial, tangential, and axial velocities in cylindrical coordinates (r, θ, z) are of the forms u = u(r), v = v(r), and w = $z\bar{w}(r)$. These solutions are found to represent a rather large class of three-dimensional viscous vortex motions. The class of solutions contains Burger's analytic solution for an unconstrained one-celled vortex as a special limiting case. The solutions obtained show that vortex motions are possible which have more than one "cell." That is, the flow may not simply spiral in toward an axis and out along it as in a one-celled configuration but may have nested regions of successively reversed axial flow. The behavior of the solutions, in passing from single to multiple-celled configurations, is discussed and the solution for the extremely interesting case of a two-celled analog to Burgers' unconstrained vortex, which probably occurs quite often in nature, is given in closed form. An interesting outcome of the investigation discussed is that, for a given narrow range of dimensionless parameters governing the flow, no steady solutions of the Navier-Stokes equations of the type under investigation are possible. (auth)

13048 (ANL-6304) AN EMPIRICAL MODIFICATION OF NUCLEATION THEORY AND ITS APPLICATION TO BOILING HEAT TRANSFER. Yan Po Chang (University of Notre Dame, Notre Dame, Ind.). Feb. 1961. 34p. For Argonne National Lab. Contract W-31-109-eng-38; Subcontract 31-109-38-1158.

From the equations of momentum and energy and by the aid of established experimental phenomena, the problem of heat transfer in nucleate boiling was reduced to one consisting of three parameters: the first represents the Stanton number; the second, bubble growth; and the third, nucleation. With an empirical modification of the nucleation theory as developed by Volmer and Eyring from the Maxwell-Boltzman distribution law, an equation was obtained for the heat transfer in vigorous boiling: $(qH\sqrt{\sigma}/\rho c_p \theta_s N_A(\kappa T_s)^{3/2}) = C \exp[-n(16\pi/3)(\sigma/\Delta p)^2 (\sigma/\kappa T_s)(\rho c_p \theta_s/\rho_v \lambda)^{-m}]$, where m = 1 and 2 for organic and inorganic liquids (including liquid metals), respectively. The symbols C and n represent dimensionless numbers whose values depend on the liquid and surface condition of the heater. Application of this equation is restricted to the following cases of boiling: saturated pool boiling from either smooth or rough surfaces; saturated and subcooled forced convection boiling from rough surfaces; and early stage of saturated and subcooled forced convection boiling from smooth surfaces. The validity of this equation for vigorous boiling was tested for more than a dozen different liquids under different pressures and different surface conditions. By introducing an eddy thermal diffusivity, a general equation was obtained, valid for the whole range of nucleate boiling. (auth)

13049 (ANL-6308) A TEMPERATURE DISTRIBUTION ANALYSIS ALONG A THERMAL RADIATING FIN OF NON-UNIFORM THICKNESS. Marion J. Janicke and Louis C. Just (Argonne National Lab., Ill.). Feb. 1961. Contract W-31-109-eng-38. 10p.

The general differential equation of a thermally radiating fin is presented for the situation of a uniform heat source along the base of the fin. An electronic analog solution of a fin of nonuniform thickness with one-dimensional steady-state radiant heat transfer is presented. The specific example is concerned with a constant rate of variation of thickness; however, any general configuration could be used. (auth)

13050 (BNL-636) A SURVEY OF BULK-BOILING STUDIES IN PRESSURIZED WATER REACTOR SYSTEMS. H. Susskind (Brookhaven National Lab., Upton, N. Y.). Aug. 1960. 16p.

A general survey was made of the published literature to determine the current status of the bulk-boiling studies of pressurized-water systems in the 1500- to 2000-psia pressure range. This survey includes departure-from-nucleate-boiling ("burnout") heat flux correlations and other thermal considerations, two-phase pressure drop correlations, flow redistribution, and other hydrodynamic considerations, under steady-state and transient conditions and uniform and nonuniform heat flux distributions. The information is evaluated, and areas requiring further development are indicated. 17 references. (auth)

13051 (HW-62763) CONTRACTION LOSSES AND HIGH TEMPERATURE PRESSURE DROP DETERMINATIONS FOR TUBE BUNDLES. W. J. Gartin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 25, 1960. Contract W-31-109-eng-52. 69p.

Tests were performed by charging a known configuration of elements and measuring the pressure drop at various flow values from 100 to 575°F. An analysis of the data is given and is compared with the results obtained from equations which were derived for contraction losses and snap ring contraction losses. The commonly used temperature correction factors yielded satisfactory correlations of PRTR data, but would not yield satisfactory correlation of the high-temperature data. The experimental equipment did not permit an independent evaluation of the skin friction, but it was concluded that the value assumed is not far from the correct value. (B.O.G.)

13052 (LA-2501) SHAPE FACTORS FOR CONDUCTION OF HEAT. Harry J. Otway (Los Alamos Scientific Lab., N. Mex.). Sept. 1960. Contract W-7405-ENG-36. 36p.

Experimental measurements were made, by use of a direct electrical analog, of the heat conduction shape factors for cylinders and square prisms enclosed by spheres. The results had an estimated error of less than 1.5%. The size ratio of the interior members to the sphere was varied, as well as their penetration into the sphere. These results were compared with the approximation made by matching the surface area of the inner member to an equivalent sphere and applying the theoretical solution for concentric spheres. Results for various geometries are presented in nondimensional form; they were fitted to a cubic equation by the method of least squares. (auth)

13053 (NP-9868) FORMULATION OF THE THEORY OF TURBULENCE IN AN INCOMPRESSIBLE FLUID. H. W. Wyld, Jr. (Illinois. Univ., Urbana and Space Technology Labs., Inc. Physical Research Lab., Los Angeles). Jan. 1, 1961. 42p. (STL/TR-61-0000-GR013)

The theory of turbulence in an incompressible fluid was formulated using methods similar to those of quantum field theory. A systematic perturbation theory was set up, and the terms in the perturbation series are shown to be in one to one correspondence with certain diagrams analogous to Feynman diagrams. From a study of the diagrams it is shown that the perturbation series can be rearranged and partially summed in such a way as to reduce the problem to the solution of three simultaneous integral equations for three functions, one of which is the second-order velocity correlation function. The equations have the form of infinite power series integral equations, and the first few terms in the power series are derived from an analysis of the diagrams to the sixth order. Truncation of the integral equations at the lowest nontrivial order yields Chandrasekhar's equation, and truncation at a higher order yields the equations discussed by Kraichnan. (auth)

13054 (NP-9913) THE HEAT TRANSFER AND FLOW FRICTION CHARACTERISTICS OF FIVE OFFSET RECTANGULAR AND SIX PLAIN TRIANGULAR PLATE-FIN HEAT TRANSFER SURFACES. Technical Report No. 49. D. C. Briggs and A. L. London (Stanford Univ., Calif.). Nov. 30, 1960. Contract Nonr 225(23). 76p.

Basic heat-transfer and flow-friction design data are presented for eleven different configurations of highly compact plate-fin surfaces. Five surfaces are of the offset rectangular-fin type and six are of the plain triangular-fin type. Some cores were constructed of aluminum and others involved a combination of stainless steel and nickel construction suitable for high-temperature applications. One surface has an area compactness exceeding 1300 sq ft of surface/cu ft of volume between plates. It is by far the most compact surface tested on the Stanford program and, moreover, it was of stainless-steel construction suited to high-temperature service. (auth)

13055 (NYO-9069) PEBBLE BED FRICTION FACTOR AND THERMAL EXPANSION TESTS. Research Report No. 4316. C. A. Leeman (Babcock & Wilcox Co. Research Center, Alliance, Ohio). Aug. 31, 1960. Final Report for Sanderson and Porter. Contract AT(30-1) 2207, S & P Subcontract No. S-11. 60p.

Tests were conducted to determine the friction factor of randomly packed beds of $\frac{3}{4}$-in.-diameter spheres in 8- and $15\frac{1}{4}$-in.-diameter beds, and of $1\frac{1}{2}$-in.-diameter spheres in a $15\frac{1}{4}$-in.-diameter bed. The bed depths were varied in an attempt to isolate the effects of entrance and exit losses. The bed Reynolds number, based on sphere diameter, was varied from 5000 to 50,000. The friction factor values obtained were essentially straight lines of practically zero slope when plotted against Reynolds number. There were significant differences between the friction factors for different bed arrangements which were believed to have been due to unaccounted for factors, such as wall effects. Tests were run to observe the effects of thermal expansion of a randomly packed bed of spheres in a cylindrical container. A 16-in.-diameter bed was filled to a depth of 18 in. with $1\frac{1}{2}$-in.-diameter coated graphite spheres. This bed was cycled between ambient temperature and 1500°F for 12 cycles, the bed depth being measured in the cold and hot condition for each cycle. Because many of the balls were partially burned up due to failure of the silicon-carbide coating, the bed height showed a continuous decline and, for this reason, no conclusions about thermal expansion could be made from the readings taken. (auth)

13056 (ORNL-3026) BURNOUT HEAT FLUXES FOR LOW-PRESSURE WATER IN NATURAL CIRCULATION. W. R. Gambill and R. D. Bundy (Oak Ridge National Lab., Tenn.). Dec. 20, 1960. Contract W-7405-eng-26. 54p.

Twenty-nine experimental determinations of burn-out heat flux were made with water flowing by natural circulation through electrically heated vertical tubes with and without internal twisted tapes and through rectangular cross sections of three aspect ratios. Heated lengths varied from 10 to 33 in., system pressure at the test-section flow exit from 14.7 to 26.3 psia, inlet subcooling from 36 to 170°F, and burn-out heat flux from 13,000 to 218,500 Btu/hr/sq ft. Tests were made with both unrestricted and restricted return flow paths. Three correlations were developed for predicting natural-circulation burn-out heat fluxes for such conditions. Two are useful for rapid estimation but the third involves a more fundamental assessment of the coolant mass velocity at burn-out by a graphical matching of the heat flux that a given flow rate can sustain to the heat flux that will produce that flow rate. For all the data, this approach gave average and maximum deviations of 15 and 38%, respectively. It was found that use of a slip ratio of unity is adequate for burn-out prediction, and the reasons for this are discussed in detail. The small burn-out penalty incurred by a substantial restriction of return flow path, experimentally observed, is in complete accord with the theoretical model. (auth)

13057 (SB-449) COOLING AND COOLANTS FOR ELECTRICAL AND ELECTRONIC EQUIPMENT, TURBINES AND REACTORS. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). 1961. 17p.

A bibliography is presented of reports which are listed in U. S. Government Research Reports and Technical Translations. About 320 references. (J.R.D.)

13058 (TID-11557) POTENTIAL FLOW THROUGH ARBITRARY PASSAGES. James F. Heyda (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Nov. 1960. Contracts AF 33(600)-38062 and AT(11-1)-171. 7p. (XDC-60-11-152)

A small perturbation method for either two-dimensional or three-dimensional axi-symmetric potential flow through arbitrary passages, based on a recent paper in the Soviet Doklady, is presented and illustrated for the case of flow through a passage with wavy walls. A theorem characterizing the asymptotic nature of the method is stated. (auth)

13059 (TID-11563) SPATIAL TRUNCATION ERROR STUDY FOR TRANSIENT HEAT TRANSFER IBM PROGRAM. J. T. Anderson and J. M. Botje (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Nov. 28, 1960. Contracts AF 33(600)-38062 and AT(11-1)-171. 14p. (XDC-60-12-35)

A method for evaluating "spatial-truncation" errors in the THT or THT-A programs is presented. The method applies to "step" temperature changes on the surface of a problem which is several nodes in depth. A means for extending the method to several steps in series is presented (auth)

13060 (TID-11573) TEMPERATURE DISTRIBUTION IN A HEATED CYLINDER WITH AN ECCENTRIC HOLE. James F. Heyda (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Oct. 20, 1960. Contracts AF 33(600)-38062 and AT(11-1)-171. 6p. (XDC-60-11-88)

An analytical procedure is presented for determining the temperature distribution in the wall of a long hollow tube with an eccentric channel. The tube wall contains a spatially uniform heat source; its outer surface is insulated while

heat is lost by convection at its inner surface to a homogeneous fluid flowing through the channel. (auth)

13061 (WAPD-TM-249) BIBLIOGRAPHY ON TWO-PHASE HEAT TRANSFER. G. W. Maurer (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1960. Contract AT-11-1-GEN-14. 19p.

A bibliography was prepared to provide a relatively comprehensive listing of the literature on two-phase heat transfer and related topics. The bibliography should be especially useful to those beginning research on problems related to boiling heat transfer. References on bubble dynamics are included which have proved useful in the analysis of boiling phenomena. In general, the bibliography does not include references on two-phase flow pertaining to type of flow, pressure drop, and vapor fractions although it was recognized that these phenomena may influence the process of boiling heat transfer to a flowing fluid. (auth)

13062 (NP-tr-576) HEAT TRANSFER INTO A SINGLE PIPE IN THE TRANSVERSE CURRENT OF A LIQUID WITH LOW PRANDTL NUMBER. A. A. Andreevskii (Andreyeskiy). Translated from Inzhener. Fiz. Zhur. Akad. Nauk Belorus. S.S.R., No. 10, 46-51. 11p.

Results are presented of an investigation into the heat transfer of a 22-mm-diameter single pipe in the ambient flow of molten metal with Prandtl number close to 0.03. Experiments covered the range Pe = 300 to 700. (auth)

13063 ANALYTICAL STUDY OF HEAT TRANSFER RATES FOR PARALLEL FLOW OF LIQUID METALS THROUGH TUBE BUNDLES: II. Aaron J. Friedland and Charles F. Bonilla (Brookhaven National Lab., Upton, N. Y.). A.I.Ch.E. Journal 7: 107-12(Mar. 1961).

A theoretical analysis of heat transfer to liquid metals in parallel flow through a tube bundle, following the method of Lyon, results in an equation that agrees within 10% with the calculated values. The conditions are fully developed turbulent flow, constant heat flux at the wall, and an infinite number of tubes arranged on an equilateral triangular pitch. The hexagonal flow area assignable to any tube is approximated by a circle of equal area, and the velocity distribution of Bailey for an annulus is assumed to apply from the inner wall to the circle of maximum flow. The range of conditions is: pitch-to-diameter ratio, 1.375 to 10; Reynolds number, 10^4 to 10^6; Prandtl number, 0 to 0.1; and Peclet number, 0 to 10^5. Laminar and slug flow Nusselt numbers are also determined. (auth)

13064 AN EXACT SOLUTION FOR A THREE-DIMENSIONAL UNSTEADY GAS FLOW OF THE DOUBLE WAVE TYPE. L. V. Komarovskiĭ (Kuibyshev Tomsk State Univ., [USSR]). Doklady Akad. Nauk S.S.S.R., 135: 33-5(Nov. 1, 1960). (In Russian)

In previous experiments waves of the first order, of an order less than one, and double waves for potential gas flow were investigated. An analysis is presented of the double wave without the assumption of potential flow. Attention is given mainly to an accurate solution for the equation of unstable gas flow with three arbitrary functions. (R.V.J.)

13065 FORCED CONVECTION IN A TWO-DIMENSIONAL LAYER WHEN THERE IS AXIAL SYMMETRY. L. I. Rubinshteĭn (Bashkirian State Univ., Ufa, [USSR]). Doklady Akad. Nauk S.S.S.R., 135: 553-6(Nov. 21, 1960). (In Russian)

The boundary problem in forced convection in a two-dimensional layer with axial symmetry was analyzed. (R.V.J.)

13066 HEAT TRANSFER. Alan Jesse Chapman. New York, The MacMillan Co., 1960. 460p.

A textbook is presented on heat transfer, offering the fundamental approach in a suitably rigorous manner. All three modes of heat transfer are treated, and the cases where more than one mode is operative are discussed. A working knowledge of mathematics and the fundamentals of thermodynamics and fluid dynamics is assumed, however a basic treatment of fluid viscous dynamics is given where it pertains to convective heat transfer. (T.R.H.)

13067 FLUID FLOW MEASUREMENT. (to California Research Corp.). British Patent 862,891. Mar. 15, 1961.

A method for measuring the rate of fluid flow in pipelines and other fluid-conducting passages is outlined. In this method, a known small amount of a radioactive fluid is injected into the flow stream and a downstream point is monitored by a detector which integrates with respect to time the radioactivity passing the point. The integral count is inversely proportional to the inverse of the flow rate and can be used to calculate the relative flow rate or the absolute flow rate; in the latter case, it is necessary to perform a calibration run on a short length of an equivalent conduit. Various applications of the method are discussed. (D.L.C.)

Instrumentation

13068 (AERE-R-3352) A PHOTOELECTRIC DEVICE FOR SETTING A MEASURING MICROSCOPE. H. M. Davis and W. H. Lockwood (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). Aug. 1960. 7p.

A description is given of a photoelectric scanning device, containing a measuring microscope, to permit a continuous comparison of the spectra of an unknown to a standard. Replicate determinations of the position of a line showed a variation of 1 μ. Reproducibility when measuring diffuse lines did not exceed ± 2 μ. (B.O.G.)

13069 (ANL-6292) A LOW DEAD-TIME NEUTRON-COUNTING SYSTEM. Robert J. Epstein and Donald C. Thompson (Argonne National Lab., Ill.). Jan. 1961. Contract W-31-109-eng-38. 16p.

A counting system capable of processing input pulses at an average rate in excess of 3×10^5 counts per second with less than 10% counting loss because of instrumental dead time is described. The system is capable of detecting thermal neutrons in the presence of a high γ background. It consists of a fission counter, a preamplifier, linear amplifier, and integral discriminator. Components of the system are described in detail, and circuit diagrams and layout information are given. Factors governing the design are discussed; testing procedures and the performance are outlined. (auth)

13070 (ARF-3187-2) ELECTROSTATIC CLASSIFICATION OF SUBMICRON AIRBORNE PARTICLES. Progress Report, December 15, 1960 to February 15, 1961. G. Langer (Illinois Inst. of Tech., Chicago. Armour Research Foundation). 6p. Contract AT(11-1)-578.

Optimum charger design studies were conducted on the charger described in the preceding report. The results were judged by the color and size of the classified deposits, the stability of the aerosol filament in the charger gap, and the amount of the heterogeneous salt aerosol precipitated in the charger. The layout of the classifier is given, and the operating conditions under which consistent classification is achieved are described. Electron micrographs are given showing the Tyndall spectra exhibited by the deposits. (For preceding period see ARF-3187-1.) (B.O.G.)

13071 (BNL-5258) PULSE TESTER AND TRIGGER GENERATOR. A. Feltman (Brookhaven National Lab., Upton, N. Y.). Jan. 19, 1961. 4p.

Development of a small portable pulse tester for checking cosmotron cables is described. A circuit diagram is included. (J.R.D.)

13072 (BNL-5259) BERYLLIUM FOIL MONITOR FOR EXTERNAL PROTON BEAM. P. Feldman and C. Swartz (Brookhaven National Lab., Upton, N. Y.). Dec. 21, 1960. 4p.

An experimental device to monitor the external proton beam at the Cosmotron is described. In operation a beryllium foil is exposed to the beam and then rotated to a counter where the short lived radioactivity is measured, thus minimizing the beam density saturation problem inherent in most other counters. Various unstable isotopes that may be formed by high-energy proton bombardment of beryllium-9 are listed. (J.R.D.)

13073 (CREL-953) A BINARY TO DECIMAL CONVERTER FOR KICKSORTER READOUT. L. B. Robinson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1960. 43p. (AECL-1162)

A solid-state binary-to-decimal converter for kicksorter readout is described. The unit converts a binary number from a kicksorter channel into decimal form by a pulse counting technique and then presents the decimal information, as binary coded voltage signals on four output lines, at rates up to 10^4 decimal digits per sec. The output is suitable for recording by sequential devices such as typewriters, paper tape punches, and magnetic tape recorders. (auth)

13074 (NAA-SR-Memo-1505) NAA UNCOMPENSATED IONIZATION CHAMBER TESTS IN SUPO. M. F. Huntsinger (North American Aviation, Inc., Downey, Calif.). Nov. 1, 1955. 10p.

An uncompensated ionization chamber for monitoring reactor power was developed. To obtain chamber response data at a high neutron flux level in a water boiler reactor, the ion chamber and associated electronic equipment were tested in the SUPO reactor. The ion currents obtained at each power level under conditions of complete ion collection are given. The ion currents were a linear function of power. The saturation characteristics revealed the necessary collection voltages. (M.C.G.)

13075 (NAA-SR-Memo-4483) DESCRIPTION OF NEW IN-CORE NEUTRON FLUX MONITORS. C. R. F. Smith (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [nd]. 21p.

Advantages are enumerated for continuous neutron flux monitoring for power reactors. Several neutron monitoring techniques in current use, as well as two novel but untried methods, are described and criticized. A program is proposed for the development of prototype neutron flux monitors from the novel concepts. (auth)

13076 (NARF-60-34T) NITROUS-OXIDE DOSIMETRY SYSTEM. D. A. Flory and W. R. McIntosh (Convair, Fort Worth, Tex.). Jan. 23, 1961. Contract AF33(600)-38946. 63p. (FZK-9-152)

Development of a nitrous oxide dosimetry system based on the reactions reported by Harteck and Dondes is reported. The dosimeters, which are capable of measuring integrated γ doses over a range of 10^8 to 10^{12} ergs/g(C), are of simple construction and are relatively inexpensive. With the complementary vacuum system, eight of the simplified dosimeters can be filled and read out per hour. Experimental results on temperature dependence, dose-rate dependence, postirradiation stability, and the effect of varying the amount and pressure of the nitrous oxide gas are reported. Calculations on the neutron sensitivity, G-value, W-value, and air-equivalence of the dosimeter are also included. Results show that this dosimetry system is a valuable tool in radiation-effects testing. (auth)

13077 (NP-9610(Pt. II)) PHOTOVOLTAIC CELLS. PART II. AN ANNOTATED BIBLIOGRAPHY. Maureen A. Pearcy, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Dec. 1960. 41p. (SB-60-28(Pt. II)).

An annotated bibliography consisting of 93 references to material published in 1959 and 1960 is presented on photovoltaic cells. (B.O.G.)

13078 (NP-9859) A SMALL PORTABLE SALINOMETER. Technical Report XXIII. Jerome Williams (Johns Hopkins Univ., Baltimore. Chesapeake Bay Inst.). Jan. 1961. Contract Nonr 248(20). Project NR 083-016. 22p.

Salinity may be calculated from a known relationship involving the electrical conductivity and water temperature. A small portable instrument operating from flashlight batteries is described which measures these two parameters in situ and essentially performs the calculation to a direct readout accuracy of ±0.3% salinity. With the aid of calibration data, this accuracy may be increased to ±0.05% salinity. (auth)

13079 (NP-9867(p.36-8)) A HIGH-VOLTAGE, HIGH-CURRENT THYRATRON MODULATOR. J. P. Kitchen (Naval Research Lab., Washington, D. C.).

A pulse-forming network using a hydrogen thyratron switch was designed for use as an injector for the electron-beam storage ring in electron guns. The network includes a transformer, as well as a switch, and gives a pulse of amplitude 320 kv with a flat pulse top ±0.5% for 0.2 μsec. (D.L.C.)

13080 (NP-9684) A SIMPLE MAGNETOMETER FOR BETA-SPECTROSCOPY APPLICATIONS. J. Żylicz and W. Prokurat (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). May 1960. 14p. (PAN-155/I-A)

A simple magnetometer, based on the properties of the permalloy probe, was constructed. It is a simplified and somewhat modified instrument of the type due to Peregud. Measurements are made using a compensation method in which the compensation current is proportional to the magnetic field intensity, and the magnetometer is used as a null-indicating device. The sensitivity of the instrument varies with the probe dimensions in the range 0.1 to 1 mgauss. If the direct compensating current is replaced by a pulsed current the accuracy falls but the range of field strength measured increases twofold. (auth)

13081 (NYO-7994) TRANSISTORIZED TIMER STUDIES. Technical Memorandum No. 55. David L. Bowler, William W. Cowles, Morton Lewin, and Richard D. Martin—N. W. Mather, ed. (Princeton Univ., N. J. Project Matterhorn). Feb. 11, 1958. ,62p.

A description is given of the operation and testing of transistorized circuits developed for a multi-channel counting type timer design to replace the designs using tubes. A theoretical study was made of the transistor transient response to predict the response to inputs with a rapidly rising leading edge, the ramp-rise function, and to show what conclusions may be drawn with regard to the optimum utilization of transistors in switching circuits. (B.O.G.)

13082 (SCR-253) DESIGN OF HIGH-CURRENT-OUTPUT, LOW-GAIN PHOTOMULTIPLIER CIRCUITS. R. W. Corwin and R. M. Tidwell (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. Contract AT(29-1)-789. 10p.

It is often necessary to design a photomultiplier circuit to deliver high output current with a low over-all gain. A circuit to do this can be built by applying low voltage on the early stages and then increasing stage voltage uniformly to give high voltages during the last stages. An analytical treatment is presented for a specific problem. (auth)

13083 (SCTM-89-60(24)) A VERSATILE, SOLID-STATE MULTIPLEXING TECHNIQUE. Joseph B. Szymanski (Sandia Corp., Albuquerque, N. Mex.). Apr. 1960. 34p.

Multiplexing by means of solid-state devices offers some distinct advantages over electromechanical methods. The multiplexing function is studied to reveal the problems. Transistors are utilized and developed into a suitable switch design. Practical information is given on the design of a solid-state multiplexer, as well as data on a model constructed for a Junior APAR. (auth)

13084 (SCTM-371-60(71)) THE SANDIA CORPORATION 12-INCH TRANSONIC WIND TUNNEL ANALOG-TO-DIGITAL DATA GATHERING SYSTEM. Donald R. MacKenzie (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 49p.

The operating and maintenance instructions for the 12-in. transonic wind tunnel analog-to-digital data gathering system are presented, and tunnel components are described. (auth)

13085 (SCTM-402-60(14)) FEASIBILITY STUDY OF A THERMISTOR VACUUM GAUGE. John F. Taylor (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 25p.

A feasibility study was made of using a thermistor as the sensing element of a Pirani-type vacuum gage. It was decided that in spite of the many problems that might arise in such an application it should be possible to measure pressures of 0.1 to 100 μ, provided reasonable controls are placed on the thermistor parameters. (auth)

13086 (SCTM-428-60(14)) THE UNBALANCED LINE DIRECTIONAL COUPLER. L. J. Allen (Sandia Corp., Albuquerque, N. Mex.). Feb. 1961. 19p.

The coupling and directional characteristics of an unbalanced line directional coupler are analyzed. Certain assumptions are made to idealize the conditions of operation, but an extension of the method used in the analysis would make it suitable for adaptation to any particular conditions of operation. The results of this analysis are the basic design equations needed for the design of unbalanced line directional couplers. (auth)

13087 (SRB-60-8) MICROMINIATURIZATION OF PASSIVE NETWORKS. An Annotated Bibliography. A. A. Beltran, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Dec. 1960. 103p.

This annotated bibliography, consisting of 170 references, is concerned primarily with distributed parameter networks, null and notch networks, micromodules, microsystem circuits, solid-state circuits, and the components and techniques applicable to passive network microminiaturization. (auth)

13088 (TID-11569) TEST PROGRAM FOR EVALUATION OF A SILICON DIFFUSED JUNCTION FAST NEUTRON DOSIMETER. W. L. Weiss (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Oct. 12, 1960. Contracts AF33(600)-38062 and AT(11-1)-171. 8p. (XDC-60-10-146)

A description is given of a test program that is designed to determine the response of the silicon-diffused-junction fast-neutron dosimeter to various test conditions, primarily to monoenergetic neutrons, to determine its usefulness as a fast-neutron dosimeter. (auth)

13089 (TID-11927) CALIBRATION OF CHROMEL-CONSTANTAN THERMOCOUPLES FOR NUCLEAR HEAT RATE SENSORS. J. H. Madison, Jr. (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Jan. 23, 1961. Contracts AT(11-1)-171 and AF33(600)-38062. 118p. (XDC-61-2-41)

Data obtained by the calibration of 2-mil-diameter 28-gage chromel-constantan thermocouple wire for nuclear-heating-rate sensors are reported. Analysis of the data is presented, showing that temperature measurement errors of ±0.75°C or more may be expected if the average temperature emf characteristics for these thermocouples is used to convert the measured emf of the heat-rate-sensor thermocouples. A method of calibrating the heat-rate-sensor thermocouples without disturbing them is described. The use of this method should result in an estimated reduction of temperature emf uncertainty by a factor of 10 (i.e., of the order of 0.075°C or less). (auth)

13090 (UCRL-6200) OBSERVATIONS ON THE RESPONSE OF TWO p-n JUNCTION DIODES TO PROTONS. J. Benveniste, R. Booth, and A. C. Mitchell (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 22, 1960. Contract W-7405-eng-48. 24p.

The response of two silicon p-n junction diodes was measured for protons up to 13.3 Mev. In one case the dependence of depletion layer thickness with bias voltage was found to be $T \propto V^{0.46}$. The observed resolution, made up of contributions from crystal noise, beam width, and scatterer thickness, was about 1% for 9-Mev protons. (auth)

13091 (WADD-TR-60-562) A SOLID STATE BRAGG-GRAY CAVITY CHAMBER. Victor H. Ritz and Frank H. Attix (Naval Research Lab., Washington, D. C.). Oct. 1960. Contract AF MIPR (33-616)59-27. 23p.

An attempt was made to construct the solid-state analog of a Bragg-Gray cavity ionization chamber. Thin layers of materials sensitive to radiation were placed between walls of C, Al, Cu, Sn, or Pb. Two types of sensing agents were employed; thin layers of anthracene with ultraviolet-induced luminescence that degrades upon irradiation, and 6-μ-thick polyethylene terephthalate (Mylar) films with an optical density that at 3250 A increases upon irradiation. Results in a Co^{60} γ-ray field with the anthracene disagree sharply with theory, while the Mylar film yields excellent agreement (±5%) with theory. A preliminary attempt to discriminate between the fast neutron and γ-ray dose in a nuclear reactor was unsuccessful. (auth)

13092 (WAPD-BT-21(p.59-68)) PRESSURE DIFFERENTIAL TRANSDUCER PERFORMANCE DURING A REACTOR LOSS-OF-FLOW TRANSIENT. D. L. Crum, Jr. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The theoretical transient-response characteristics of a low-range pressure-differential transducer and connecting piping were analyzed to determine the adequacy of such an instrument system to measure the pressure-differential transients during reactor loss-of-coolant-flow tests. Approximate expressions are derived which are used in conjunction with the transducer system equations to evaluate the effects of flow coastdown rate, fluid temperature, fluid compressibility within the transducer and connecting piping, and elasticity of the connecting piping upon the transient performance of the transducer. The results indicate that the transducer diaphragm may experience small pressure oscillations superimposed on the actual pressure transient, but not of sufficient magnitude to obscure the desired data. (auth)

13093 (AEC-tr-4424) UNIVERSAL METHOD FOR STABILIZING THE REGULATION OF SCINTILLATION SPECTROMETER. S. Haun and D. Kamke. Translated by Lydia Venters (Argonne National Lab.) from Nuclear Instr. & Methods, 8: 331-8(1960). 15p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 1565.

13094 (CEA-tr-R-1099) IDENTIFICATION DES MAXIMA "DE PAIRES" OBTENUS AVEC LE SPECTROMETRE GAMMA A EFFET COMPTON. (Identification of Maximum Pairs Obtainable with Compton Gamma Spectrometers). V. R. Burmistrov (Bourmistrov) and Yu. A. Kazanskii (Kazanski). Translated into French from Pribory i Tekh. Eksp't., No. 1, 32-3(1957). 7p.

The Compton scintillation spectrometer does not give a unique relationship between the energy of the gamma ray and the spectrum obtained because, in addition to the fundamental maxima from the Compton effect, there are maxima determined by the effect of "pairs." A procedure permitting the partial suppression of the pair maxima by the use of an installation with threshold discriminator in the control circuit of the scintillation counter is given. By comparing the spectra obtained with and without suppression of the maxima, the maxima caused by the pair effect can be identified with certainty. (J.S.R.)

13095 (UCRL-Trans-633(L)) MEASUREMENT OF THERMAL NEUTRON DENSITY IN A UNIFORM MEDIUM BY MEANS OF NUCLEAR EMULSIONS CHARGED WITH BORON. C. Beets, H. Breny, and J. Fournaux. Translated by Alexander Robinson from Phot. corpusculaire, Colloq. intern. 2e, Montreal, 1958, 399-410(1959). 26p.

An improvement in a method using boron-charged nuclear emulsions for the measurement of thermal neutron density is reported. It was found that nearly half the variance between the plates exposed to the same flux was eliminated if the thickness of the emulsion was determined after development. Methods for obtaining both relative and absolute measurements are described. The response of plates with varying boron content was investigated. The number of traces of reaction $B^{10}(n,\alpha)Li^7$ was found to be proportional to the boron content per cm^3 of emulsion. (M.C.G.)

13096 GENERAL METHOD OF CORRECTION FOR INSTRUMENTATION ERROR, APPLIED TO THE INTERPRETATION OF X RAY. M. Tournarie (Commissariat a l'Energie Atomique, Saclay, France). Bull. soc. franc. mineral. et crist., 81: 278-86(1958). (CEA-1135). (In French)

An analysis was made of the measurement sequence formed by apparatus and calculation in crystallographics. The errors are classified, and their evolution is followed throughout the sequence so that the best from a series of sequences may be chosen and its limitations known. There is, in effect, a top limit of separating power. Varied applications are possible. (auth)

13097 SCINTILLATION COUNTING WITH ORGANIC PHOSPHORS. B. Lionel Funt (Univ. of Manitoba, Winnipeg). Can. J. Chem., 39: 711-16(Mar. 1961).

Current techniques employed in scintillation detection of beta emitters are reviewed. Internal liquid scintillation counting, with a number of homogeneous mixed solvent systems, is described. Heterogeneous counting systems containing radioactive material in the dispersed phase include scintillating gels, thickened scintillators, and emulsions, and a number of methods embodying direct counting of active deposits on filter paper. Heterogeneous systems with the radioactive material in the continuous phase are described and include plastic capillary counters, plastic filaments, or organic crystals wetted with aqueous solutions. (auth)

13098 A RAPID NUMERICAL ANALOG CONVERTER. Yehonathan Hazoni. Compt. rend., 251: 343-5(July 18, 1960). (CEA-1649). (In French)

A conventional amplitude selector has a dead time of 0.5 μsec per channel, i.e., a mean dead time of about 50 μsec for a 200-channel selector. The use of tunnel diodes and transistorized circuits has been studied with a view to resolving this difficulty. The numerical analog converter described makes it possible to envisage reducing this dead time by a factor of 10. (auth)

13099 MEASUREMENT OF AVERAGE IONIZATION ENERGY OF α PARTICLES AND γ RAYS IN SILICON BY MEANS OF n-p JUNCTIONS. Lydie Koch, Jean Messier, and Jean Valin. Compt. Rend., 252: 74-8(Jan. 4, 1960). (In French)

The average ionization energy ϵ in silicon for α particles of 9 to 40 Mev and β particles of 277 to 660 kev was measured with N-P junctions. It was found that the value of ϵ depends neither on the nature nor the energy of the incident particle. The value is $\epsilon = 3.55 \pm 0.1$ ev. (tr-auth)

13100 ZENITH ANGLE RESPONSE FOR INCLINED MESON TELESCOPES. R. P. Kane and U. R. Rao (Physical Research Lab., Ahmedabad, India). Current Sci. (India), 29: 425-7(Nov. 1960). (In English)

The response characteristics of inclined meson telescopes were calculated for different values of θ, the angle of inclination of the incoming particle with respect to the zenith. It was found that most of the radiation came from a narrow cone along the axis of the telescope. For telescopes having a semi-angle of 20° in the narrower plane and inclined to the vertical at 45°, the mean inclination of all radiation recorded was at 42.0°, and 50% of the recorded radiation was incident within a range of approximately ±5.5° of this mean value. (M.C.G.)

13101 MODIFYING A TELEMETRY SYSTEM FOR BALLOON-BORNE NEUTRON DETECTION. Leon Hillman (Automation Dynamics Corp.) and Robert C. Haymes. Electronics, 34: No. 11, 60-3(Mar. 17, 1961).

Instruments for the measurement of diurnal variation of the neutron intensity at altitudes above 80,000 ft are described. Two neutron counters, one filled with BF_3 enriched with B^{10} and the other using boron depleted in the B^{10} isotope, were carried aloft by a balloon for the measurements. For the flights the usual radiosonde equipment was retained except for the addition of the hypsometer for high-altitude low-pressure measurements. At the receiver the functions of position tracking and demodulation of the radiosonde audio modulation were accomplished. Circuit diagrams are given. (M.C.G.)

13102 A SEMI-CONDUCTOR PORTABLE HIGH STABILITY GENERATOR FOR FIXED FREQUENCIES. K. I. Nazarov. Izmeritel'naya Tekh., No. 11, 45-7(Nov. 1960). (In Russian)

A description is given of a high-stability generator which has found wide use in radio-radiation measurements and in traveling laboratories. This light-weight frequency generator with a range from 10 cycles to 1 Mc is constructed with semiconductors. The circuit utilizes a thermostatically controlled oven that gives the system a stability of 1 ppm for temperatures ranging from 0 to 40°C. Superior performance over its vacuum-tube counterparts KG-A and KG-B is noted. (TTT)

13103 MAGNETIC ALIKHANYAN-ALIKHANOV SPECTROMETER WITH TWO LARGE WILSON CHAMBERS. A. T. Dadayan and G. V. Badalyan (Inst. of Physics, the Academy of Sciences, Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 12: No. 4, 109-19 (1959). (In Russian)

The design and specifications are presented of the new Alikhanyan-Alikhanov spectrometer that is capable of recording particles with 500 to 600 m_e mass. Two cross-sectional views of the apparatus are shown, as well as the main magnetic spectrometer, lower and upper Wilson chambers, and the electron control scheme. Improvements initiated with the new apparatus aim at raising the efficiency of the spectrometer for recording nuclear interactions at 10^{11} ev. (R.V.J.)

13104 COUNTER FOR HEAVY IONS. N. N. Komarov and A. A. Seredkin (Inst. of Applied Geophysics, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz., 1663-70(Nov. 1960). (In Russian)

A method for recording heavy-ion spectra is analyzed, and formulas are derived for heavy-ion-counter design and construction. The results of tests made with the counter are presented. (R.V.J.)

13105 DROP IN IONIZATION CONCENTRATION FOLLOWING STOPPAGE IN LIQUID IONIZATION CHAMBER. V. I. Ivanov (Moscow Inst. of Engineering Physics). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 134-9(1960). (In Russian)

A theoretical analysis is made of the changes in current in a plane parallel chamber as a function of time after ionization stoppage, considering recombination. Theoretical values and experimental data are correlated, assuming equal mobility of positive and negative ions in chambers filled with n-heptane, isooctane, and benzene. The results indicate good agreement. The magnitudes of ion mobility are found for each liquid: 1.6×10^{-4}, 1.3×10^{-4}, and 0.5×10^{-4} (cm/sec)/(t/cm), respectively. (R.V.J.)

13106 CHEMICAL INSTRUMENTATION. S. Z. Lewin (New York Univ., New York). J. Chem. Educ., 38: A135-6; A138; A140; A143; A146; A148; A150; A152; A154; A156; A158-60; A162(Mar. 1961).

A survey is presented of the basic principles, characteristics, and limitations of the nuclear radiation detectors which find important applications in chemical work. The detectors described include: electroscopes, ionization chambers, proportional counters, Geiger-Mueller counters, and scintillation detectors. Schematic diagrams are included. (M.C.G.)

13107 SIMPLE AMPLIFIER AND PULSE-HEIGHT ANALYSER FOR AN X-RAY SCINTILLATION COUNTER. B. B. Trott (University Coll., Cardiff, Wales). J. Sci. Instr., 38: 74-7(Mar. 1961).

A simple circuit, using only four valves, was developed to serve as amplifier and pulse-height analyzer for an x-ray scintillation counter. Results obtained suggest that large noise pulses in the photomultiplier may be caused by repeated optical feedback. (auth)

13108 SOME RESULTS OBTAINED IN DEVELOPING A RECORDING GEIGER-COUNTER X-RAY INTENSITY MONITOR. A. E. Kiss and N. Patla (Sir John Cass Coll., London). J. Sci. Instr., 38: 78-9(Mar. 1961).

A single-beam monitor is described which samples the general background radiation scattered from an x-ray beam by a thin foil, and its behavior compared to that of the main spectrometer counter receiving the K component from the same beam. Equal fractional changes of counting rate for monitor and main counter are observed when x-ray beam fluctuations are caused by changes in the x-ray tube current. No such simple relationship holds between monitor and main counter for changes in x-ray tube voltage. The response required of a counter for monitoring purposes is discussed briefly and the suitability of an end-window argon-filled Geiger counter established experimentally. (auth)

13109 SMALL HIGH-TEMPERATURE VACUUM FURNACE. G. Arthur and J. H. Priest (C. A. Parsons and Co., Ltd., Newcastle upon Tyne, Eng.). J. Sci. Instr., 38: 80-2(Mar. 1961).

A small high-temperature vacuum furnace, using tantalum as the heating element, is described. The main features of the furnace are its simplicity of construction, the absence of internal water cooling, and the comparatively low power requirements (2.5 kw at 2200°C). (auth)

13110 VERY HIGH SPEED DUAL-PURPOSE IMAGE-CONVERTER CAMERA. F. H. Grover (Atomic Weapons Research Establishment, Foulness, Essex, Eng.). J. Sci. Instr., 38: 86-91(Mar. 1961).

A laboratory instrument that uses a commercially available image-converter tube as a fast shutter for very short exposure photographs of high velocity self-luminous phenomena is described. Exposure times of 10 mμsec are obtained with pulses derived from a line pulse circuit having a coaxially constructed thyratron switch. The equipment may also be used for streak photography with a choice of sweep times in the range 1 to 25 μsec. (auth)

13111 A DEVICE FOR MEASURING TRITIUM OXIDES. A. P. Zavyalov, A. G. Istomina, and V. V. Markelov. Med. Radiol., 5: No. 12, 57-60(Dec. 1960). (In Russian)

A description is given of a device for measuring tritium oxides with the aid of liquid scintillators. The device is assembled from standard blocks. Its sensitivity is up to $1 \cdot 10^{-9}$ c/ml, while with a modified monitor it is $1 \cdot 10^{-10}$ c/ml. (auth)

13112 TRANSISTORS IN REACTOR INSTRUMENTATION. G. G. Ballard. Nuclear Eng., 6: No. 58, 117-20 (Mar. 1961).

The use of transistors for reactor control is discussed. Equipment was developed which fulfills the necessary fail-to-safety requirements when reactor safety is directly involved and provides switched outputs for incorporation in conventional interlock circuits. The use of transistors makes possible an indefinitely long working life at approximately one-hundredth the power of its valve counterpart. Both germanium and silicon transistors may be used as modulators or choppers. The use of transistors as thermocouple amplifiers, for detection of low-current signals, in pulse counting equipment, as pulse-height discriminators, and in trip and alarm units is discussed. (M.C.G.)

13113 NEUTRON SENSITIVE BORON COATED THERMOPILE. Leszek Łabno, Wacław Dąbek, and Witold Byszewski (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 685-8(1960). (In English)

A neutron sensitive thermopile, developed in the Institute of Nuclear Research, is described. Its properties are discussed and for illustration purposes the neutron flux distribution curve along the axis of one of the WWR-S reactor channels is given. (auth)

13114 NEUTRON SPECTRUM TEMPERATURE MEASUREMENTS BY MEANS OF BORON-GLASS FILTERS. Tadeusz Rzeszot and Zbigniew Weiss (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 689-703(1960). (In English)

The temperature of a neutron beam from the horizontal channel of the WWR-S reactor was measured by means of the boron-glass filter method. A BF_3 counter of the NUM-30 W type with 1/v characteristic was used. The characteristics of the counter were proved using a neutron spectrometer. For interpretation of the experimental data, a spectrum consisting of a Maxwellian component of temperature T plus a Fermi spectrum was assumed. The temperature T and the Fermi cut-off energy E_c were estimated by means of two independent methods. (auth)

13115 ABSOLUTE MEASUREMENTS OF BETA ACTIVITIES IN LIQUID SCINTILLATORS. Edward T. Jőzefowicz (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 713-17(1960). (In English)

A method of absolute measurement of β activities by dissolving a sample in a liquid scintillator was developed. It consists of the extrapolation of bias curves to zero point of discrimination. Some problems of this method are discussed. (auth)

13116 PARTICLE IDENTIFICATION IN NUCLEAR EMULSIONS BY THE SCALE METHOD. A. A. Rimskii-Korsakov and O. V. Lozhkin (Radium Inst., the Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 5, 20-3 (Sept.-Oct. 1960). (In Russian)

A new method is suggested for particle identification by determining the special track characteristics that depend on the number and distribution of grains longer than the predetermined ones on a uniformly divided ocular scale. The method is simple and has good resolving ability. (tr-auth)

13117 ELECTROSTATIC SPECTROMETER FOR NUCLEAR RECOILS. V. K. Grigor'ev (Inst. of Theoretical and Experimental Physics, the Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 5, 33-4(Sept.-Oct. 1960). (In Russian)

A new type of electrostatic spectrometer performing in the energy range from several kev for particles with Z = 1 possessing large light power up to 50% from 4π is described. The method is based on the method of measuring the energy by the time-of-flight. (tr-auth)

13118 UNIVERSAL SCINTILLATION RADIOMETER RUS-3. REPORT I. MEASURING PANEL. I. B. Keirim-Markus, A. M. Lushchikhin, V. V. Markelov, and L. N. Uspenskii. Pribory i Tekh. Ekspt., No. 5, 35-40(Sept.-Oct. 1960). (In Russian)

A design is given of the electronic scheme of a portable universal scintillation dosimeter performing with semiconductors with universal power supply. (R.V.J.)

13119 NUCLEAR MAGNETOMETER. M. V. Ryzhkov, O. O. Bronzov, and A. P. Stepanov (Ural Polytechnic Inst.). Pribory i Tekh. Ekspt., No. 5, 41-5(Sept.-Oct. 1960). (In Russian)

A magnetometer based on the principle of free precision capable of measuring the magnitude of the earth's magnetic field every 2 sec is described. The precision order of relative measurements is 5.5×10^{-4}%. (tr-auth)

13120 VACUUM X-RAY MONOCHROMATOR FOR DETERMINING THE ABSOLUTE EFFICIENCY OF RADIATION COUNTERS. M. A. Rumsh, A. P. Lukirskiĭ, I. A. Karpovich, and V. N. Shchemelev (Leningrad State Univ., U.S.S.R.). Pribory i Tekh. Ekspt., No. 5, 67-73(Sept.-Oct. 1960). (In Russian)

Descriptions are given of a monochromator designed on the principle of the Bragg spectrometer with the wavelength range limited by $\lambda = 2 \sin \zeta_{max} = 19.3$ A for mica crystal. A specially constructed Geiger counter capable of determining the counter efficiency at arbitrary wavelengths was used for determining the absolute intensities of monochromatized beams in the monochromator. A discriminating electron x-ray tube is used for generating variable characteristic lines. (tr-auth)

13121 STABILITY OF PHOTOMULTIPLIERS. Yu. A. Nemilov, G. N. Belozerskiĭ, and L. D. Soshin (Radium Inst., the Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 5, 81-5(Sept.-Oct. 1960). (In Russian)

The stability of photomultipliers with Cs–Sb emitters and fused dynodes was investigated under various working conditions. It was found that the stability of photomultipliers is closely related to the load and operating conditions. Practical suggestions are offered for a more efficient utilization of various photomultipliers. (tr-auth)

13122 VARIATION OF THE ANODE CURRENT AT FEU (PHOTOMULTIPLIER TUBES) UNDER THE INFLUENCE OF MAGNETIC FIELDS. V. V. Matveev, E. E. Minaeva, and A. D. Sokolov. Pribory i Tekh. Ekspt., No. 5, 86-93(Sept.-Oct. 1960). (In Russian)

A magnetostatic chamber was used for determining the influence of a constant magnetic field on the performance of the most popular photomultipliers (FEU-29, 24, 13, C, and 23). The data gives the maximum magnetic-field intensity (magnetostatic parameter) and the necessary protection against the magnetic influence on scintillation counters performing in magnetic fields. (tr-auth)

13123 PLUTONIUM RADIOACTIVE IONIZATION MANOMETER. L. P. Khavkin. Pribory i Tekh. Ekspt., No. 5, 101-6(Sept.-Oct. 1960). (In Russian)

Calculations for a radioactive ionization manometer with radioactive substance uniformly distributed on the inner surface of the cylinder show that the characteristics of such a manometer with a fine plutonium layer are nonlinear due to the emission of recoil atoms. A method is suggested for linearization of the performance characteristics. Descriptions are given of a safe plutonium source radioactive ionization manometer with linear characteristics for the range of 10^{-3} to 100 mm Hg. Results of calibration with various gases and semiempirical formulas are developed for evaluating the relative sensitivity of radioactive manometers to various gases. (tr-auth)

13124 CHERENKOV DETECTOR UTILIZING COMPLETE INTERIOR REFLECTION. A. S. Vovenko, A. L. Lyubimov, I. A. Sabin, V. S. Stavinskiĭ, and T. T. Stoichev (Joint Inst. for Nuclear Research, U.S.S.R.). Pribory i Tekh. Ekspt., No. 5, 119-21(Sept.-Oct. 1960). (In Russian)

The design of a Cherenkov counter using total intrinsic reflection of Cherenkov radiation from the boundary interface and the results of tests made with the counter are described. Separation of particles with velocities up to $\beta \simeq 0.95$ from a strong background of fast particles was achieved by means of several counters. (R.V.J.)

13125 COMPTON SCINTILLATION γ SPECTROMETER WITH INCREASED EFFICIENCY. I. E. Konstantinov and V. A. Strakhova. Pribory i Tekh. Ekspt., No. 5, 125-6 (Sept.-Oct. 1960). (In Russian)

An intensification of Compton scintillation γ spectrometer light power was achieved, without complicating the electron scheme, by means of a controlling ring-shaped crystal. The block diagram of the device is presented. The controlling crystal is ϕ 80 mm and 30-mm high, with channel ϕ 18 mm and collimator channel ϕ 6 mm. The diameter and height of the analyzing crystal were 29 and 13 mm, respectively. The pulses of the controlling crystal photomultipliers converge to the same amplifier. The described spec-

trometer can be utilized for measuring γ radiation requiring collimation. (R.V.J.)

13126 ON A METHOD OF CALIBRATING SCINTILLATION GAMMA-SPECTROMETERS. V. V. Ovechkin, I. A. Pirkin, A. S. Polyakov, and D. V. Ochkin. Pribory i Tekh. Ekspt., No. 5, 126-8(Sept.-Oct. 1960). (In Russian)

A method is suggested for the absolute calibration of a γ spectrometer for a wide range of energies without using γ source standards but utilizing some of the known intensities with some weak γ quanta (or K x-ray quanta) with energies of $\geq$ 100 kev. The total absorption of weak quanta by an NaI(Tl) crystal surface is $E_\gamma = 90$ kev $\mu = 7.5\ cm^{-1}$ and $\epsilon_0 = S_0/N_0 \simeq \omega_0$ (where ω_0 is the relative solid angle at which the crystal is seen from the source). Measurements were made of the function $\epsilon = f(E_\gamma)$ for the NaI(Tl) crystal with ϕ 40 × 50 mm at distance R = 5.3 cm ($\omega_0 = 3.2 \times 10^{-2}$) using Hg^{203}, Cs^{137}, Ce^{144}, and Se^{75} and the obtained function $\epsilon = f(E_\gamma)$ was confirmed by standard measurements with γ sources of Ra^{226} and I^{131}. The advantages of this method for calibrations of scintillation γ spectrometers at energies of 30 to 2200 kev is the limited number of Hg^{203}, Cs^{137}, Ce^{144} + Pr^{144}, Ra^{226}, and I^{131} which did not have to be standardized according to their intensities. (R.V.J.)

13127 A NEW PULSE ASSEMBLY FOR GEIGER-MUELLER COUNTERS. I. P. Karabekov, G. A. Marikyan, and V. M. Kharitonov (Physics Inst., Academy of Sciences, Armenian SSR). Pribory i Tekh. Ekspt., No. 5, 129(Sept.-Oct. 1960). (In Russian)

According to a new scheme, assembled pulses are shaped directly by the counter resistance current connected to a common cathode of a group of counters. The pulses of the hodoscope cell are taken from resistances connected to the counter (filament) anode chain. The pulse assembly parameters do not depend on the hodoscope cell chain parameters, and they are uniform. They are not affected by pulses passing from one cell to another. Pulses with parameters U_{yield} = 0.05 to 0.1 v, τ_{front} = 0.3 to 0.4 μsec, and τ_{pulse} = 2 to 2.5 μsec were obtained with a large number of counters and a good pulse assembly (tr-auth)

13128 INCREASING THE SENSITIVITY OF PHOTOGRAPHIC METHODS OF RECORDING DENSE SHOWERS OF CHARGED PARTICLES. I. D. Rapoport (Scientific Research Inst. of Nuclear Physics, Moscow State Univ., U.S.S.R.). Pribory i Tekh. Ekspt., No. 5, 130-1(Sept.-Oct. 1960). (In Russian)

Previously the detection threshold for relativistic particles (passing at the radius of $\sim 10^{-1}$ cm) were evaluated at $\sim 10^4$; this is equivalent to the energy of $\sim 10^{12}$ ev for primary shower-inducing particles. The increased sensitivity detector utilized an x-ray film which was highly sensitive on both sides, (Agfa-Rapid) and a UFD-2 multiplier screen as a luminophor. The film enclosed between two luminescence screens increased the order of detection of fast electron flux. According to calibrations with a collimated beam (10 mm^2 cross section) of electrons from the radioactive source of Sr^{90}, the system was capable of recording showers with $\sim 10^3$ particles or with a primary particle energy of $\sim 10^{11}$ ev. The detector can be utilized as a component in an emulsion chamber. (R.V.J.)

13129 SENSITIVITY AND HEAT CONDUCTIVITY OF NUCLEAR EMULSIONS AT LOW TEMPERATURES. N. V. Zavaritskii, V. A. Sviridov, and K. D. Tolstov (Joint Inst. for Nuclear Research, USSR). Pribory i Tekh. Ekspt., No. 5, 131-2(1960) Sept.-Oct. (In Russian)

The heat conductivity and sensitivity of NIKFI-R saturated with triethanolamine and Ilford G-5 at 4 to 1.5°K were measured to determine the applicability of nuclear emulsions with an oriented hydrogen target at the surface of the emulsions. The sensitivity of the above emulsions, were taken as 100% at T = 300°K. The sensitivity of both types of emulsions at T ~ 0.1°K did not vary much from the corresponding magnitudes at T ~ 1.5°K. No reason to anticipate any large change in sensitivity near the point of absolute zero exists. (R.V.J.)

13130 MEASUREMENT OF THE ENERGY OF NEGATIVE π MESONS USING A STAR DETECTOR. A. F. Dunaĭtsev, Yu. D. Prokoshkin, and T'ang Hsiao-Weĭ (Joint Inst. for Nuclear Research, USSR). Pribory i Tekh. Ekspt., No. 5, 133(Sept.-Oct. 1960). (In Russian)

A star detector constructed with two scintillation coincidence counters is used for selective π^- meson recordings. The detector is capable of rapidly measuring (15 min at beam intensity of $\sim 10^3$ π^-/sec) the track and energy of π^- mesons. Track curves for π^- mesons at 160 Mev are plotted. The diagram shows that the star detector records the stars and not the stopped particles. The sensitivity of the detector to μ^- mesons is about 20 times weaker than to π^- mesons. (R.V.J.)

13131 ITERATIVE RESPONSE CORRECTION FOR A SCINTILLATION SPECTROMETER. L. D. Skarsgard, (Univ. of Toronto), H. E. Johns and L. E. S. Green. Radiation Research, 14: 261-80(Mar. 1961).

A system was established to facilitate rapid correction of extensive data on radiation spectra, measured with a NaI(Tl) scintillation crystal. The method uses a simple iterative procedure and a consistent criterion for the selection of a "best" approximation. A preliminary test for the convergence of the iterations was developed, and considerable experimental evidence is given for the validity of the solution. The methods are particularly suitable for use with an automatic computer. The response of the detector was measured experimentally and is represented by a single forty-ninth order matrix. The energy range may be altered by substituting a different response matrix in the correction program. (auth)

13132 USE OF THE FRICKE DOSIMETER TO MEASURE PHOTOELECTRIC ABSORPTION. Nathaniel F. Barr, Janet Geisselsoder, and John S. Laughlin (Sloan-Kettering Inst., New York). Radiation Research, 14: 291-5(Mar. 1961).

Experiments were run to determine if liquid chemical systems such as the Fricke dosimeter may be used to measure the amount of photoelectric absorption for a particular photon spectrum. Extinction coefficients of ferric ion in various solutions were determined relative to the extinction coefficient of ferric ion in 0.8N H_2SO_4. Energy absorption in solutions was calculated by graphical integration. Results in 1.6, 0.8, and 0.3N H_2SO_4 solutions with a variety of radiations are summarized. Optical density changes produced in 0.8N H_2SO_4 solutions containing added zinc and cadmium are given. These additions did not detectably change the G value for ferric ion production in the Fricke dosimeter. (M.C.G.)

13133 REPRESENTATION OF THE SPACE-TIME DISTRIBUTION OF RADIOACTIVE SUBSTANCES WITH THE HELP OF A CONIC γ RETINA AS IMAGE TRANSMITTER. Andreas Scheidweiler and Ernst Theunissen (Rheinisch-Westfalish Technische Hochschule, Aachen). Z. Naturforsch., 15b: 759-62(Dec. 1960). (In German)

With the help of incorporated γ-irradiating materials, motion phenomena in inaccessible spaces of the human body can be made visible. Such an apparatus consists, in

principle, of an image transmitter, which causes a representation of the radiating object, and of the signal amplifying electronic part. Because of the injurious effect of ionizing radiation the activity delivered must not be greater than is necessary for the obtention of sufficient information. The present work has the problem of investigating to what extent an optimum yield in radiation intensity can be obtained by suitable dimensioning of the image transmitter. By means of geometric consideration, it is shown how, by use of a conic γ retina, the yield can be improved with respect to an image transmitter consisting of a cylindrical bore. The results of the investigations were experimentally tested and confirmed. (tr-auth)

13134 BLOCKING OSCILLATOR DOUBLE PULSE GENERATOR CIRCUIT. J. A. Haase (to U. S. Atomic Energy Commission). U. S. Patent 2,969,507. Jan 24, 1961.

A double-pulse generator, particularly a double-pulse generator comprising a blocking oscillator utilizing a feedback circuit to provide means for producing a second pulse within the recovery time of the blocking oscillator, is described. The invention utilized a passive network which permits adjustment of the spacing between the original pulses derived from the blocking oscillator and further utilizes the original pulses to trigger a circuit from which other pulses are initiated. These other pulses are delayed and then applied to the input of the blocking oscillator, with the result that the output from the oscillator circuit contains twice the number of pulses originally initiated by the blocking oscillator itself.

13135 FUEL SLUG RUPTURE DETECTOR. Ronald S. Paul. U. S. Patent 2,974,096. Mar. 7, 1961.

An apparatus is described which detects ruptured fuel slugs and their location within a reactor having coolant channels positioned in a square lattice forming a plurality of vertical columns and horizontal rows of coolant channels. An elevator, which is positionable along the face of the reactor, is used to load and unload the coolant channels. In the instant apparatus, an I-beam is attached to the elevator and supports a plurality of radiation detectors arranged in a horizontal row, one detector for each vertical column of coolant channels. Each radiation detector is adapted to receive radiation only from the associated coolant channel in the vertical row. The outputs of the radiation detectors are each connected through an integrating circuit to a respective contact on a rotary switch. The rotary switch is adapted to sequentially engage each of the stationary contacts and transmit the output therefrom to an oscilloscope display where a pulse is shown for the output of each radiation detector. The oscilloscope beam makes one horizontal sweep for each revolution of the rotary switch. Thus, as the elevator is then raised or lowered, the condition of the fuel slugs in the coolant channels may be monitored.

13136 NEUTRON-INSENSITIVE BETA GAMMA DOSIMETER. J. A. Auxier, G. S. Hurst, and R. E. Zedler. U. S. Patent 2,974,248. Mar. 7, 1961.

A β-γ dosimeter is described which is insensitive to an intense fast neutron field. The energy of incident radiation is measured by counting pulses rather than by measuring ion current. The disclosed dosimeter measures the dose and can discriminate heavily against that produced by neutron-recoils. This discrimination is accomplished by providing a cavity inside a liner wall smaller in length than one-tenth the mean free path for ionization by 30,000-ev electrons.

13137 METHOD AND MEANS FOR INCREASING ELECTRON EMISSION. A. J. Bureau. U. S. Patent 2,974,251. Mar. 7, 1961.

A method is given for increasing the electron emission of a thoriated-tungsten emitter operable in an evacuable chamber. The chamber is first evacuated and then silicone oil vapor is introduced therein. When the partial pressure within the chamber rises to 4×10^{-4} mm Hg, due to the addition of the silicone oil vapor, electron emission from the thoriated-tungsten emitter is established. The silicone oil vapor is allowed to remain in the atmosphere of the chamber for approximately 15 min following the establishment of the electron emission, after which it is removed from the atmosphere of the chamber.

13138 IRRADIATION TRANSMUTATION CAPSULE AND METHOD OF FABRICATION. C. M. Gordon. U. S. Patent 2,975,113. Mar. 14, 1961.

A method is described for the fabrication of an irradiation transmutation capsule capable of withstanding high irradiation fluxes. A homogeneous mixture of powdered aluminum and an oxide, fluoride, or a mixture thereof of a target element selected from the lanthanide and actinide elements is compacted within a closed sheath metal sleeve with pressure sufficient to induce plastic flow. This capsule can withstand a thermal neutron flux that produces an amount of heat equivalent to 1000 watts per second per square inch of surface area.

13139 RADIO RANGING DEVICES. R. W. Bogle. U. S. Patent 2,975,414. Mar. 14, 1961.

An apparatus is described which senses the location of a vehicle with respect to another body and initiates a control signal at a predetermined distance from the body. A super-regenerative oscillator circuit is arranged to have alternate transmitting and sensing phases of operation, controlled by a modulator which generates two unidirectional pulses adjustably spaced in time. The oscillator energy is transmitted to an antenna and the echo energy is sampled by the oscillator during its receiving phase producing a control signal when the echo energy is returned at the time the oscillator is in the receiving phase. A rectifier is coupled to the super-regenerative circuit through a gate circuit, and means is provided for opening the gate circuit during the time the oscillator circuit is in the transmitting phase of operation. The rectifier therefore passes a unidirectional signal in response only to the sensing phases of operation.

13140 MANIPULATOR FOR SLAVE ROBOT. Raymond C. Goertz, John H. Grimson, and Frank A. Kohut (to U. S. Atomic Energy Commission). U. S. Patent 2,978,118. Apr. 4, 1961.

A remote-control manipulator comprising two stationary master units, two slave units on a movable vehicle, and electrical connections between the master and slave units is reported. The slave units are side by side with a minimum over-all width, which is made feasible by an arrangement of transducers producing most movements of each slave unit to one side of the support of said slave unit.

13141 RADIO RANGING DEVICE. H. R. Crane, M. E. Bourns, R. T. Nieset, J. W. Gratian, and A. C. Gratian (to U. S. Atomic Energy Commission). U. S. Patent 2,980,905. Apr. 18, 1961.

A super-generative radar system is described having alternate phases of transmission and reception and being adapted to transmit for unequal durations in the absence of receiving energy and to transmit for equal and longer durations when energy of proper phase is received.

Materials Testing

13142 (CEA-1682) CONTROLE DE L'ETANCHEITE DES ELEMENTS COMBUSTIBLES PAR RESSUAGE D'HELIUM— CAS DU REACTEUR G2. (Checking the Sealing of Fuel Elements by Helium Sweating—Case of the Reactor G2.) Bernard Blanc, Michel d'Orival (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucleaires, Saclay) and Serge Choumoff (Compagnie Française Thomson-Houston, Paris). 1960. 48p.

The G-2 slug is a welded, hermetically sealed unit. The seal is checked by placing the fuel element in an atmosphere of helium under pressure and then measuring the quantity of helium it releases in a vessel under vacuum. The theoretical aspect and the conditions for industrial application are reviewed, and the installations are described. (auth)

13143 (HW-65701) FUEL CORE TESTER - UT-2. C. L. Frederick and G. L. Waldkoetter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 18, 1960. Contract AT(45-1)-1350. 41p.

An instrument that nondestructively tests uranium-fuel-element cores by ultrasonic methods is described. Because fuel cores containing untransformed uranium (or certain other variations in grain size) may fail in service, these should be rejected. The UT-2 is designed to automatically reject the cores that show undesirable variations in grain size. A second ultrasonic test is incorporated in the UT-2; this tests for surface defects and internal cracks and rejects the defective cores. (auth)

13144 (NP-9573) NUCLEAR RADIATION TESTS OF MINUTEMAN FLIP-FLOP CIRCUIT AT THE GODIVA II FACILITY, LOS ALAMOS, NEW MEXICO. H. B. Almond and W. E. Spencer (Boeing Airplane Co., Seattle). Sept. 9, 1959. 8p. (BOE-5-7870-7839).

A bread-boarded Minuteman flip-flop was tested in the nuclear radiation environment of the Godiva II facility at Los Alamos, N. M. The subject flip-flop is a transistorized Eccles-Jordan type bistable circuit. Transient and permanent damage measurements were made with the flip-flop operating at 50 kc during Godiva bursts of 2.34×10^{10}, 2.01×10^{11}, 1.32×10^{12}, 1.10×10^{13}, and 1.07×10^{13} plutonium nvt. No triggering failure or erratic triggering occurred on any exposure; however, a slight modulation of the output voltage limits was recorded, the amount of modulation being greater for the larger exposures. No permanent damage was evident at the end of the tests. (auth)

13145 (NP-9903) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Progress Report No. 2, October 1960–December 1960. (Lockheed Nuclear Products, Marietta, Ga.). Contract NASw-114. 90p. (NR-118)

Development testing was performed on the prototype tensile test loop. Included were calibration of the stress measuring and recording system, alignment studies, and extensometer development. A small portable vacuum table was designed. Reevaluations and revisions of the list of materials for test programs were made. Fabrication techniques were perfected, correlation specimens manufactured, and specimen designs developed. Modifications were made of the tensile-compression test loop to improve accuracy and reliability. A study was made of the feasibility of reducing the cost of the beam port shield through redesign. The first major overhaul of the GNL refrigerator was completed. Fabrication was begun on components for the test loop transfer system. Calorimeters were constructed for evaluation tests. (M.C.G.)

13146 (OEL-NUCLEAR-29) THE DEVELOPMENT OF AN ALTERNATIVE TO THE STEAM AUTOCLAVE TEST FOR ZIRCALOY-2. (Orenda Engines Ltd., Malton, Ont.). October 1960. 35p. (AECL-1113)

A developmental program to reduce hydrogen pick-up and time in testing Zircaloy-2 reactor components is described. Recommendations include construction of an autoclave that will permit continuous observations of specimens during steam testing and further investigations of the chemical oxidation of Zircaloy. (J.R.D.)

13147 (ORNL-3059) DEVELOPMENT OF NONDESTRUCTIVE TESTS FOR THE EXPERIMENTAL GAS-COOLED REACTOR FUEL ELEMENT. R. W. McClung and R. A. Nance (Oak Ridge National Lab., Tenn.). Mar. 2, 1961. Contract W-7405-eng-26. 30p.

The Title I design fuel assembly and each of its components for the Experimental Gas-cooled Reactor are described. The development of the specific nondestructive testing techniques for the evaluation of the components and the fabricated fuel capsule is presented. These techniques include penetrants, pulse-echo and resonance ultrasonics, radiography, eddy-currents, helium leak testing, and others. Discussion is made on the capabilities and limitations of these techniques for the specific inspection problems and reasons presented for the selection of the inspection requirements. (auth)

13148 (TID-11555) PHOTO THERMOELASTIC INVESTIGATION OF A TRIMETALLIC STRIP. Part II. Herbert Becker and Angelo Colao (New York Univ., New York). July 1960. Contracts AF 33(600)-38062 and AT(11-1)-171. 22p. For General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati. (XDC-60-12-32)

The results of the photothermoelastic investigation of three trimetallic strips are reported. The two principal purposes of the program were to obtain data on the edge stresses of a square-ended strip and to acquire further information on the effect of end shape of an internal bar upon the stresses in a caged strip. The principal results were the indication of a virtual stress discontinuity in the square-ended strip and a reduction in the concentration factor using a round-ended center bar instead of a square-ended bar. (auth)

13149 APPLICATION OF TM 170 TO RADIOGRAPHIC CONTROL OF METALS. Bogusław Osuchowski (Electro-Technical Inst., Warsaw). Nukleonika, 5: 771-85(1960). (In Polish)

Results are presented of investigations made with Tm^{170} γ sources and conclusions are drawn of the possibilities of application of this isotope to nondestructive testing. For different source activities and dimensions, specific ranges of application were determined. Radiologic protection problems arising during the application of Tm^{170} sources are discussed. (auth)

13150 THE ROLE OF INTERRUPTIONS IN THE LONG-LIFE STRENGTH TESTING. I. I. Trunin, V. S. Tseĭtlin, and G. I. Zeitman (Central Scientific Research Inst. for Tech. and Machine Construction, USSR and Taganrogsk Factory "The Red Boilermaker," USSR). Zavodskaya Lab., 27: 66-71(1961). (In Russian)

An attempt was made to evaluate the effect of interruptions on the result of life tests and on the appearance of brittle fracture of heat-resistant steels. Brittle Cr–Ni steels were used in the static tests comparing the results of parallel series of continuously and of intermittently loaded specimens. Metallographic and mechanical testing methods completed the series. The intermittent series mocked up the conditions prevailing during the operation

of energy generating stations. The data obtained indicated that the heat resistance characteristics are greatly dependent on the heat treatment at the time of application or removal of the load and on the original properties of the steels. Interruptions with temporary reduction of the load did not exert a noticeable effect on the long-life strength. Previously obtained data indicated that this strength might be changed by continuously applied loads if the deformation does not exceed 1% and if the load is removed suddenly. (TTT)

13151 EXACT DETERMINATION OF THE PARAMETRIC DEPENDENCE OF THE LONG-LIFE STRENGTH. V. I. Nikitin (Polzunov Central Turbine Boiler Inst., USSR). Zavodskaya Lab., 27: 71-4(1961). (In Russian)

During the investigation of the ability of materials to withstand the effect of continuous loads while being exposed to high temperatures it was found that the time required for fracture or loss of integrity greatly depends on the lattice defects which in turn follow the Boltzman distribution. The constant figuring in the parametric equation derived by F. R. Larson and J. Miller (Transact. ASME 74: (1952) No. 2) is actually a function of the applied stress. Extrapolation of the equation does not yield good results for materials for which this constant is strongly dependent on the applied stress. The necessity of determining the coefficients figuring in the equation greatly reduces its usefulness for the rapid determination of the limit of the long-life strength. (TTT)

GEOLOGY, MINERALOGY, AND METEOROLOGY

13152 (CEA-1683) ESSAI D'UNE CLASSIFICATION DES GITES URANIFERES FILONIENS. (Classification of Uraniferous Vein Deposits). Jacques Geffroy and Jacqueline A. Sarcia (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucleáires, Saclay). Sept. 13, 1960. 11p.

On the basis of a study of French uraniferous seams and of information found in the literature from all parts of the world, especially since the first Geneva Conference, these deposits are classed according to two broad categories. The first type, bound up with the differentiation of an acid rock, fall naturally into the conventional hydrothermal category. The others fall right outside the conventional hydrothermal category and seem to be connected to some age modifications, originally of tectonic origin, of the uranium dispersed among the rocks on a regional scale. (auth)

13153 (CNG-41) L'UTILIZZAZIONE DELLA GEOCHIMICA NELLA PROSPEZIONE MINERARIA. (Utilization of Geochemistry for Prospecting). F. Tonani (Italy. Comitato Nazionale per le Ricerche Nucleari. Divisione Geomineraria, Rome). Aug. 1960. 20p.

Ore accumulation is a particular event of the natural history of the chemical elements. Geochemistry is therefore a basic science in the research for ore deposits. Some fundamental ideas of geochemistry are summarized, such as the significance of the natural persistence of the chemical composition of geologic materials and the paragenetic series of the elements and their geochemical balance. After the main geochemical relations, considered as general criteria of the ore research, the geochemical prospecting methods, based on the formation of dispersion haloes, are described. An operative classification of such methods is given. The uraniferous ore prospecting is reported as an example of the comparison between direct and indirect methods. The utility degree of such methods cannot be quantitatively determined as a general case, but one concludes that they have a non-replaceable part among the ore prospecting methods. Finally brief information is given on the state of the geochemical research and teaching organization in Italy. (auth)

13154 (CNG-57) I GIACIMENTI URANIFERI DEGLI STATI UNITI OCCIDENTALI. (The Uranium Deposits of Western United States). C. Tedesco (Italy. Comitato Nazionale per le Ricerche Nucleari. Divisione Geomineraria, Rome). Sept. 1960. 185p.

A training program on uranium geology, including visits to the most important uranium deposits of western U. S., organized by the USAEC in the summer of 1959 is reported. The first part concerns the uranium deposits of the Colorado Plateau. The uranium deposits of the Colorado Rocky Mountains are described in the second part. The third part concerns the uranium deposits of Wyoming. In the fourth part, deposits not located in a unique well-defined geographical and structural area and representing different types of mineralizations are described. (auth)

13155 (DMP/G-1) URANIO NOS DEPOSITOS DE FOSFATOS MARINHOS PERTO DE RECIFE, ESTADO DE PERNAMBUCO, NORDESTE DO BRASIL. (Uranium in the Marine Phosphate Deposits at the Port of Recife, Pernambuco State, Northeast of Brazil.) Max G. White. Translated into Portuguese by Maria Helena Vidal. Brazil. Comissão Nacional de Energia Nuclear.) 1958. 8p.

A deposit of marine phosphate is located approximately 5 miles to the north of the port of Recife, Pernambuco, near a suburban area called Olinda. The uranium concentration varies from 0.02 to 0.036% U_3O_8. The geology of the region was determined, and a generalized stratigraphic cross section of sedimentary rocks showing the position of the phosphate rocks is given. (J.S.R.)

13156 (HW-67326) 100-N AREA AQUIFER EVALUATION. Donald J. Brown and Paul P. Rowe (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 4, 1960. 13p. AT(45-1)-1350.

The hydraulic characteristics of the unconfined aquifer adjacent to the Columbia River change considerably during certain seasons of the year. These changes are the direct result of fluctuations in the river level. During the low stages of the river the ground water percolates through partially cemented sands and gravels of the Ringold formation. As the river approaches the flood stage the water table rises into the more permeable fluviatile and glaciofluviatile rocks. Using a method developed by Rowe the transmissibility and coefficient of storage of the unconfined aquifer underlying the 100-N area were determined. The measurements for these determinations were made when the river was nearing its flood stage in order to obtain the most representative values for these coefficients. Based on these data the calculated average permeability values range from 1500 to 3000 gpd/sq ft. These permeability values are consistent with those determined elsewhere on the project in similar earth materials. The calculated hydraulic characteristics of the 100-N aquifer were used to evaluate the performance of a waste water disposal facility. A tentative evaluation indicates that the infiltration capacity of the soil may control the size needed. It is estimated that the proposed 30-ft trench parallel to the river would not create a problem as a result of its effect on the water table. (auth)

13157 (NP-9893) METHODS USED TO MEASURE THE TOTAL BETA ACTIVITY OF NEW ZEALAND RAIN, AND TO IDENTIFY THE ACTIVITY WITH A NUCLEAR TEST SERIES. G. S. McNaughton (New Zealand. Dept. of Scientific and Industrial Research. Div. of Nuclear Sciences, Lower Hutt). Oct. 4, 1960. 35p. (NSR-11)

It was decided in late 1956 to measure the deposition of radioactive fall-out in New Zealand. Monthly rainfall samples were collected in stainless-steel pots at different places and returned to the processing laboratory. The pots were scrubbed with nitric acid and the rain water and washings evaporated to dryness in platinum vessels. The solid residues were mounted on celluloid planchettes and the total β activity measured with an end window counter. By comparing the decay rate of each sample with that of the slow neutron fission products of U^{235}, an estimate was made of when the nuclear explosion occurred which gave rise to the fission products of the sample. (auth)

13158 (NSEC-30) EVALUATION OF RADIOACTIVE FALLOUT. Final Report. Leonard P. Salter (Nuclear Science and Engineering Corp., Pittsburgh). Sept. 30, 1960. Contract AT(30-1)-2420. 39p.

A study was made of the fall-out pattern during a rainstorm. The Sr^{90} measurements were within the limits of sensitivity and precision required to analyze a rainstorm and demonstrated how radioactivity measurements may be correlated with meteorological data to evaluate phenomena related to fall-out. Mechanisms involved in the removal of debris from the troposphere are discussed. An evaluation was made of the Cs^{144} to Sr^{90} ratio in nuclear debris and fall-out. Data indicate that fractionation of Cs^{144} and Sr^{90} in the stratosphere is not significant. Material collected at 65,000 ft was representative of debris about three-fourths of a year older than material at 90,000 ft. Vertical mixing in the stratosphere at the latitude of Pittsburgh is slow, but may be observed on a 10,000-ft scale over a one-year period. Although most of the Sr^{90} in precipitation was found to be soluble in rain water, the solubility of Cs^{144} was found to be very low. Meteorological data and procedures used in collection and radiochemical analysis are appended. (C.H.)

13159 (ORO-370) RADIOACTIVE FALLOUT. Annual Progress Report. P. K. Kuroda, L. M. Fry, H. L. Hodges, Tin Mo, and H. E. Moore (Arkansas. Univ., Fayetteville). Dec. 31, 1960. Contract AT(40-1)-2529. 34p.

A sharp increase in the Sr^{89}/Sr^{90} ratio in rain was observed at Fayetteville, Ark., after the French nuclear detonations of Feb. and Apr. 1960. Experimental data obtained suggest the possibility that part of the debris from atom bombs detonated in the tropical region may enter the stratosphere. (auth)

13160 (SC-4542(RR)) MATHEMATICAL PROBLEMS IN SEISMOLOGY. W. J. Byatt and G. P. DeVault (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 82p.

Some mathematical problems in seismology are treated. Equations of motion are solved for various simple cases; expressions are derived for earth motion caused by an initially spherically symmetric disturbance in an ideal half-space and for a half-space covered by a layer. Surface waves are considered, and the possible effects of various factors on the frequency content of Rayleigh waves are studied. Numerical work is presented for the displacement caused by the sudden injection of a volume into a homogeneous half-space (E. Pinney's model) and for ray paths in a medium of arbitrarily varying index of refraction. An iteration-variation method is developed for solving wave equations in media of variable index of refraction. (D.L.C.)

13161 (SC-4546(RR)) SURFACE TEMPERATURE ANOMALIES IN MOUNTAIN AREA WEATHER ANALYSIS. J. W. Reed (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 18p.

Average seasonal temperatures for synoptic map times were tabulated for the western United States. Although a few of these are available in Weather Bureau publications, the majority were interpolated from maximum-minimum or average temperature summaries and are used to calculate and plot surface temperature anomalies which are well conserved in air mass propagation over rough terrain and around the clock. This allows more accurate frontal description than is available in ordinary analysis of the orography and sun-affected parameters of pressure, temperature, dew point, and wind. (auth)

13162 (SCR-281) SOIL DISPLACEMENT INDUCED BY AIR BLAST. William R. Perret (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. Contract AT(29-1)-789. 22p.

The transient displacement of ground by the blast wave generated by a nuclear explosion equivalent to 40 kt of TNT was measured during Operation Plumbbob. The explosive charge was suspended from a captive balloon 700 ft above a dry playa lake bed called Frenchman Flat. The soil environment of this area consists of a uniform 200-ft-thick mass of weakly cemented sandy silt. Instruments were installed at stations 650 and 1350 ft from GZ on a blast line and at various depths up to 200 ft. An exploded view is included of the relative displacement gage used in the measurements. A typical profile of density and seismic velocity is presented, and relative positions of the instrument stations and burst points are illustrated by schematic sketches. Data are presented graphically on overpressure, relative displacement, peak displacement, and deflection contours at various depths and ranges. (C.H.)

13163 (TEI-754) PRELIMINARY GEOLOGIC MAP OF THE TIPPIPAH SPRING NW QUADRANGLE, NYE COUNTY, NEVADA. A. B. Gibbons, E. N. Hinrichs, W. R. Hansen, and R. W. Lemke (Geological Survey, Washington, D. C.). Apr. 1960. 21p.

A preliminary geologic map of the Tippipah Spring NW Quadrangle, Nye County, Nevada, is given. Also included is an index map of Nevada showing the quadrangle within the Nevada Test Site. (M.C.G.)

13164 (TEM-1033) THICKNESS, CHARACTER, AND STRUCTURE OF UPPER PERMIAN EVAPORITES IN PART OF EDDY COUNTY, NEW MEXICO. C. L. Jones (Geological Survey. Washington, D. C.). Oct. 1959. 31p.

In central eastern Eddy County, N. Mex., unconsolidated deposits of quaternary age and redbeds of Triassic age attain a thickness of about 700 ft, and rest unconformably on evaporites of late Permian age. The upper Permian evaporites are 3000 to 3800 ft thick and are divided, in descending order, into the Rustler, Salado, and Castile formations. The Rustler is largely gypsum rock, the Salado is dominantly halite rock, and the Castile contains both anhydrite rock and halite rock. The salt and anhydrite beds of the Salado and Castile are intruded by narrow dikes of alkalic rock along which the evaporites are little altered. The sedimentary rocks have a generally southeastward regional dip, but locally are warped in gentle folds of low amplitude and fairly small lateral dimensions. (auth)

13165 (TID-11879) TRITIUM CONCENTRATION IN NATURAL WATER SOURCES IN THE EASTERN MEDITERRANEAN AREA. Annual Progress Report No. 3, January 1960-January 1961. J. R. Gat (Gutmann) (Weizmann Inst. of Science, Rehovoth, Israel). Feb. 15, 1961. Contract AT (30-1)-2166. 17p.

Results are reported from measurements of tritium concentration in samples of rain water, ground water, river water, and sea water collected in the eastern Mediterranean area. The tritium was isotopically enriched in the water samples by a three-stage electrolytic process, and the overall enrichment of the deuterium isotope was measured with a mass spectrometer. The deuterium enrichment factor was calculated. The efficiency of the analytical procedure is discussed. (C.H.)

13166 (TID-11923) LETTER PROGRESS REPORT [ON ATMOSPHERE MONITORING PROGRAM] FOR JANUARY 1961. Rex C. Wood and S. P. Jones (General Mills, Inc., Minneapolis). Feb. 21, 1961. Includes Paper: ISOTOPE RATIOS OF FISSION PRODUCTS IN THE STRATOSPHERE AND IN TROPOSPHERIC FALLOUT. S. C. Stern. Contract AT(11-1)-401. 11p.

Progress is reported in the design of a molecular sieve pump and the development of a field-operational atmosphere-sampling system. The feasibility of the use of biological ma-

terials as nonradioactive tracers of stratospheric circulation patterns is reported to be under investigation. Results are included from a comparison between fall-out and stratospheric debris in the mid-temperate latitudes. In the absence of tropospheric injections, good agreement was found between stratospheric and tropospheric production sources and dates. An anomaly was observed in late 1958 and 1959, following the October series of Arctic Soviet Tests. Several explanations are offered to explain this anomaly, which consider the possibility of chemical and particle-size fractionation, the height of the main cloud in the stratosphere, and a unique exit for debris injected into the Arctic stratosphere. (C.H.)

13167 (TID-12128) FINAL REPORT ON $A^{40}-K^{40}$ DATING OF IGNEOUS AND METAMORPHIC ROCKS IN WESTERN MONTANA. R. J. Hayden and J. P. Wehrenberg (Montana State Univ., Missoula). [1960?]. Contract AT (45-1)-1057. 10p.

Igneous and metamorphic rocks from the major igneous Precambrian areas of western Montana were dated by $Ar^{40}-K^{40}$ measurements obtained by use of the isotope dilution method. Data are tabulated. (C.H.)

13168 (USASRDL-TR-2088) OPERATIONS OF THE FALLOUT GROUP OF PROJECT 50.3. W. J. Richards and B. F. Watson (Army Signal Research and Development Lab., Fort Monmouth, N. J.). Aug. 15, 1960. 68p.

An evaluation was made under field conditions, during Operation Plumbbob, of the Signal Corps method of fall-out prediction. Meteorological data were collected and fall-out forecasts were made on a daily basis for each scheduled shot. The method of fall-out prediction was found to have several shortcomings despite its many virtues. Dose rates forecast by the Signal Corps method are compared with observed dose rates. (C.H.)

13169 (AEC-tr-4472) DETERMINATION OF THE VOLUMETRIC WEIGHT OF ORES FROM THE ATTENUATION OF GAMMA-RAYS. A. A. Tatarnikov. Translated from Razvedka i Okhrana Nedr., 23: No. 4, 17-23(1957). 18p.

A method of determining volumetric weights of ores is described. The method is based on the attenuation of γ radiation as it passes through the sample. The volumetric weights of ores found by this method are compared with weights obtained on cut blocks of the ore. The method is applicable to all types of ore and is recommended for use instead of the block-cutting method for mineral deposit surveys. (J.R.D.)

13170 THIRD REPORT OF THE FEDERAL COMMISSION ON RADIOACTIVITY MONITORING IN THE FEDERAL COUNCIL. P. Huber. Bull. Eidgenöss. Gesundh., Beil. B., No. 1, 35p. (Feb. 6, 1960). (German text, pp.1-10; tables and figures, pp.11-25; French text, pp.26-35.)

A detailed report is presented on radiation monitoring in Switzerland including the location of monitoring stations and a description of the equipment used and data collected from July 1958 to Sept. 1959. Measurements were made of the air, soil, surface, and reservoir waters and of milk, food, and bones. It was observed that the radioactivity in Switzerland from atomic-weapon tests presents no danger to the people. (T.R.H.)

13171 SCANDIUM IN MINERALS OF THE WOLFRAMITE GROUP. L. F. Borisenko and L. N. Komissarova (Inst. of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements, Academy of Sciences, USSR and Moscow State Univ.). Doklady Akad. Nauk S.S.S.R., 135: 430-3 (Nov. 11, 1960). (In Russian)

Scandium occurrence and distribution in wolframite minerals was analyzed. The results of chemical and spectral analyses of various specimens from various tungstate deposits bearing Sc_2O_3 are tabulated. (R.V.J.)

13172 THE DATA OF LEAD ISOTOPE GEOLOGY RELATED TO PROBLEMS OF ORE GENESIS. R. S. Cannon, Jr., A. P. Pierce, J. C. Antweiler, and K. L. Buck (Geological Survey, Denver). Econ. Geol., 56: 1-38(Jan.-Feb. 1961).

Isotope analyses of lead from rocks and ores provide a new tool for attacking problems of ore genesis. About 2000 such analyses now available from more than 20 laboratories were compiled and studied for this purpose. The data now available suggest partial answers to some questions and serve to define other, new problems, not previously recognized. Their greatest import, however, is to illustrate the potential future significance of lead-isotope studies. Ore-lead, as shown two decades ago, ranges widely in isotopic composition. Recent studies show that traces of lead in ordinary rocks of the earth's crust exhibit apparently similar variations. All these variations are attributable primarily to mixing of old lead with accumulations of new radiogenic lead from decay of radioactive uranium and thorium. Each sample of lead preserves in its isotopic composition a record of its own mixing history: a composite record of the time this lead was in different environments, its past associations with uranium and thorium, and the geochemical processes that moved it from place to place. Integrated study of all these variables will throw light on many difficult problems of ore genesis when adequate techniques are developed. Progress will be slow, however, until more accurate lead-isotope analyses can be made at lower cost and more objective criteria developed for interpreting measured isotopic compositions in terms of geologic history. (auth)

13173 DISTRIBUTION OF URANIUM ORE DEPOSITS IN THE ELK RIDGE AREA, SAN JUAN COUNTY, UTAH. Russell H. Campbell and Richard Q. Lewis (Geological Survey, Menlo Park, Calif. and Geological Survey, Columbia, Ky.). Econ. Geol., 56: 111-31(Jan.-Feb. 1961).

The Elk Ridge area of southeastern Utah contains uranium ore deposits in two lower members of the Chinle formation of Late Triassic age. These "favorable areas" contain all the mines and important prospects. The ore deposits are flat-lying tabular to lenticular bodies in fluvial sandstone beds of the Chinle with fine-grained black uranium minerals chiefly interstitial to sand grains and as replacement of carbonaceous material. Most of the ore-bearing sandstone beds are discontinuous lenses intertonguing with and overlain by relatively impermeable mudstone. Contact of the host sandstone with the underlying Moenkopi seemed to be a prerequisite for ore as the ore bodies are generally within a few feet of such contact areas and sandstone lenses separated from the Moenkopi by gray mudstone are generally not ore bearing. The consistent association of ore deposits with the Chinle-Moenkopi contact suggests that mineralizing solutions were introduced into the host beds from their areas of contact with the Moenkopi formation. Impermeable barriers overlying ore-bearing parts of the host sandstones were probably an important control on the deposition of ore minerals from solution. Hypofiltration of metallic constituents from ascending ore solutions was also probably important. It is possible that the overlying barriers formed traps for H_2S gas or fluid hydrocarbons and thus localized a reducing chemical environment in which ore minerals were later precipitated. (auth)

13174 THORIUM MINERALIZATION IN THE LEMHI PASS AREA, LEMHI COUNTY, IDAHO. Alfred L. Anderson (Cornell Univ., Ithaca, N. Y.). Econ. Geol., 56: 177-97 (Jan.-Feb. 1961).

The thorium mineralization in the Lemhi Pass area of southeastern Lemhi County, Idaho, is directed along simple to complex shear and fracture zones, and reopened copper and gold-quartz veins and lodes, in impure quartzitic and phyllitic rocks of the Precambrian Belt series. Some of the shear and fracture zones are more than 40 ft across and comprise broad zones of irregularly mineralized rock reaching distances to 2000 ft in length. These zones contain notable concentrations of thorium and rare-earth elements along with considerable amounts of Ba, alkali metals, Ca, Fe, P, S, and Si and meager amounts of Nb, U, and perhaps other related elements. Minerals identified so far include thorite, allanite, monazite, xenotime (?), euxenite(?), apatite, specularite, barite, alkali feldspar, calcite, biotite, phlogopite, sericite, chalcedony, and quartz. The most characteristic minerals are thorite, specularite, barite, and quartz. The specularite and thorium-bearing minerals are intimately associated and were introduced into the deposits after the micas and in advance of the barite, feldspar, calcite, and quartz. Except for the specularite and quartz and in part the barite, feldspar, calcite, and thorite, the minerals are not distinguishable without the microscope. Some of the deposits contain several per cent thoria and comparable amounts of rare-earth oxides, but the average is generally under 1%. The area has an appreciable reserve of lode thorium. Some of the deposits are in or are being brought into production. (auth)

13175 THE DETECTION OF RADIO-ACTIVE MINERALS WITH INFRARED AERIAL PHOTOGRAPHY. Erhard M. Winkler and Barry Voight (Univ. of Notre Dame, Ind.). Econ. Geol., 56: 211-12(Jan.-Feb. 1961).

In order to determine if radiation from a moderately radioactive source would influence film emulsions, especially under the conditions of aerial photography, several infrared films were tested. Commercial films were exposed to radioactive sources of different intensities, both natural and fission products. Although the distance from the camera to the source was just a few feet as compared with the altitudes common in aerial photographic flights, no effect of any radioactive source material could be observed. (M.C.G.)

13176 SOME METEOROLOGICAL FACTORS TO BE OBSERVED AT NUCLEAR INSTALLATIONS. P. Courvoisier (Federal Inst. for Reactor Research, Würenlingen, Switzerland). Neue Tech., 2: No. 12, 33-6(1960). (In English)

The collection of data on the persistence of certain atmospheric conditions at the sites of nuclear installations is suggested. As examples for such data the persistence of air-masses, the duration of precipitation, and the drift distance of air are discussed. Furthermore, the difference of daily maximum and minimum temperatures of the air is considered as indicator for convective movements of the air. (auth)

13177 MINERALOGY AND RADIOACTIVITY OF NIUE ISLAND SOILS. M. Fieldes, G. Bealing, G. G. Claridge, N. Wells, and N. H. Taylor (Soil Bureau, Wellington, New Zealand). New Zealand J. Sci., 3: 658-75(Dec. 1960).

Results of x-ray-diffraction analysis, differential thermal analysis, magnetic, and radioactivity examinations of Niue Island soils (from samples collected in 1949) are given, and problems of soil origin and agriculture are discussed. The mineralogy of the soils is unusual and shows considerable natural radioactivity. These soils have silicon contents of less than 1% and average phosphorus content of about 1%. Hakupu soils of the elevated coastal fringe contain up to 40% of crandallite ($CaAl_3(PO_4)_2(OH_6)$), 2 to 5% magnetite, much goethite, and some gibbsite. Fonuakula and Palai soil types of the inner basin consist mainly of gibbsite and goethite, with up to 8% crandallite and 1% magnetite. Crandallite decreases and gibbsite increases in passing from the raised fringe to the central depression. Crandallite contents are limited by contents of phosphorus. The relative contents of magnetite in the soils and in the underlying coral indicate that the soils are not wholly derived from coral and are probably largely derived from pumice and meteoric dust trapped in a former tidal lagoon. Spectrographic evidence supports this. Radioactivity up to thirty times greater than that of average New Zealand soils is due largely to ionium and Ra^{226} out of equilibrium with parent uranium. The ionium and radium have been trapped from sea water by reef sediments, in the former lagoon. Radioactivity measurements and related data suggest that emergence of the island from the sea occurred less than 200,000 years ago. Further study could aid in establishing the geological ages of terrace levels, thus providing a time scale for Pacific zone fossils, and in assessing effects of radioactivity on plants and animals. (auth)

13178 DEBRIS FROM TESTS OF NUCLEAR WEAPONS. Jan Sisefsky (Research Institute of National Defence, Stockholm). Science, 133: 735-40(Mar. 17, 1961).

Airborne debris from nuclear weapons tests has been collected since 1955 and examined for radioactivity. The debris was collected on glass-fiber paper with a sampling device carried by an aircraft at altitudes up to about 10 miles. Part of the filter paper is used for spectrometric determination of a number of γ-emitting nuclides, from which an age determination can be made. The remainder of the filter is radioautographed on photographic film. From the radioautograms it is possible to determine the activity of the individual particles and to locate their positions on the filter. Measurements were made of the size of radioactive particles. The particles were examined microscopically. Data are presented graphically on the activity of 950 particles of various sizes. Characteristics are described for debris from the Soviet test series of Sept. and Oct. 1959. (C.H.)

13179 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY. NUMBER 22 FOR JULY-SEPTEMBER, 1960. Tokyo, The Japan Meteorological Agency, 1960. 86p. (In English and Japanese)

Data are tabulated on the radioactivity in samples of rain water and dusts collected at various sites throughout Japan between July and September 1960. (C.H.)

13180 GEOLOGY OF THE CLAY HILLS AREA, SAN JUAN COUNTY, UTAH. Contributions to the Geology of Uranium. Thomas E. Mullens (Geological Survey, Washington, D. C.). Geological Survey Bulletin 1087-H. 1960. 79p., 1 illus.

The Clay Hills area includes 296 square miles of canyon and plateau country in southwestern San Juan County, Utah. Rocks exposed in the area were mostly deposited in a terrestrial environment and are of Permian, Triassic, Jurassic, and Quaternary ages. The aggregate thickness of these rocks is about 3,900 ft. The Cutler formation of Permian age is the oldest exposed formation and is subdivided into three red-bed tongues and two light-colored wind-deposited sandstone members: the Halgaito tongue, only partly exposed in the eastern part of the map area in the San Juan River Canyon; the Cedar Mesa sandstone member, about 700-ft thick; the Organ Rock tongue, about 350-ft thick; the De Chelly sandstone member, about 30-ft thick in the southwestern part of the area and absent elsewhere because of nondeposition; and the Hoskinnini tongue,

about 110-ft thick in most of the area, but only 42-ft thick where it overlies the De Chelly sandstone member. The Moenkopi formation of Early and Middle (?) Triassic age comformably overlies the Cutler formation, ranging in thickness from 260 to 340 ft. It is composed of a lower evenly bedded siltstone, a middle cross-laminated sandstone, and an upper evenly bedded siltstone. The Moenkopi is overlain unconformably by the Chinle formation of Late Triassic age. The Chinle formation of Late Triassic age ranges from 780 to 1,195 ft in thickness and is composed of sandstone, conglomerate, mudstone, variegated claystone, limestone, and calcareous siltstone. The Chinle can be subdivided into four divisions based on the dominance of rock types, but gradation and intermixing of rock types make it difficult to map the upper three divisions. Therefore, the Chinle is divided into the Shinarump member (lower unit) and undifferentiated Chinle (upper unit). The Shinarump member, the lower member of the Chinle formation, consists of cross-laminated sandstone and conglomerate irregularly interbedded with mudstone. It is conspicuous only in the southern part of the map area where it reaches a thickness of 176 feet. Elsewhere the Shinarump is absent or represented only by thin lenses; the local absence is due to nondeposition. The Shinarump member, where present, conformably underlies the undifferentiated Chinle formation. The undifferentiated Chinle formation can be divided into a lower unit of sandstone and mudstone; a middle unit of variegated claystone, calcareous siltstone, and limestone; and an upper unit of reddish-orange to reddish-brown interbedded siltstone and very fine grained sandstone. All contacts between units of the undifferentiated Chinle are conformable, and the upper unit conformably underlies the Glen Canyon group. The formations of the Glen Canyon group include the Wingate sandstone of Late Triassic age, the Kayenta formation of Jurassic (?) age, and the Navajo sandstone of Jurassic and Jurassic (?) age. The Wingate is a massive wind-deposited sandstone and averages about 320-ft thick; the Kayenta consists of irregularly bedded fluviatile deposits and averages about 220-ft thick; the Navajo is a massive wind-deposited sandstone that includes lenses of limestone. A complete thickness of the Navajo cannot be measured in the map area as erosion during Cenozoic time has removed the upper part of the sandstone; the maximum preserved thickness is about 600 ft. Deposits of Quaternary age, consisting of landslide blocks, terrace deposits, alluvium in present flood plains, fans, and dune sand, are widespread in the map area. The Clay Hills area is on the gently dipping west flank of the Monument upwarp. Locally the westward dip is interrupted by minor northward-trending asymmetrical folds. Normal faults are associated with the eastward-dipping limbs of the minor folds; many joints cut the sandstone strata. Interest in the mineral resources of the Clay Hills area has centered around uranium, gold, and copper. To the present time no commercially important mineral deposit has been discovered in the area, although much time and effort has been used in prospecting for uranium. (auth)

13181 ISOPACH MAPPING BY PHOTOGEOLOGIC METHODS AS AN AID IN THE LOCATION OF SWALES AND CHANNELS IN THE MONUMENT VALLEY AREA, ARIZONA. PROCEDURES AND STUDIES IN PHOTOGEOLOGY. Irving J. Witkind, William R. Hemphill, Charles L. Pillmore, and Robert H. Morris (Geological Survey, Washington, D. C.). Geological Survey Bulletin 1043-D. 1960. 34p., 1 illus.

In the Monument Valley area of northeastern Arizona, uranium-vanadium deposits are localized in strata of the Shinarump member of the Chinle formation of Triassic age that fill ancient scour channels, some of which are along the axes of broad, shallow, elongate troughs known as swales. Commonly the swales are not visible from the ground but are apparent on isopach maps of selected strata that underlies the Shinarump. To determine whether maps prepared from aerial photographs would be equally useful, a test area previously mapped in the field was mapped by photogeologic methods. The strata in the interval represented by the isopach maps are distinctive both in the field and on the aerial photographs. Both the base and top of this interval are unconformities. As the unconformity at the base of the interval is smooth and even, however, the isopachs reflect irregularities at the top of the interval, the most prominent of which are the channels and swales at the base of the Shinarump. Isopach maps made by photogeologic methods were compared with one isopach map and one channel map that were prepared by field methods. The photogeologic isopach maps delineated both the swales and the channels. This suggests that photogeologic methods are adequate for use in defining swales similar to those in the Monument Valley area. Furthermore, photogeologic methods are independent of weather and logistics problems, and can conveniently precede geologic fieldwork. Many isopach readings can be easily taken in a relatively short time. On the other hand, limitations are imposed by the need for aerial photographs from which suitable photogrammetric measurements can be made. If such photographs are not already available, the cost of obtaining them may be prohibitive. Also, the top and base of the interval to be measured must be discernible on the photographs. Accuracy is reduced where observations are widely spaced or where the top and base are widely separated horizontally. (auth)

13182 PRELIMINARY GEOLOGIC MAP AND SECTIONS OF THE MOUNT PEALE 2 NE QUADRANGLE, SAN JUAN COUNTY, UTAH. G. W. Weir and W. P. Puffett (Geological Survey, Washington, D. C.). Mineral Investigations Field Studies Map MF-141. 1960. 1p.

13183 PRELIMINARY GEOLOGIC MAP AND SECTION OF THE MOUNT PEALE 2 SE QUADRANGLE, SAN JUAN COUNTY, UTAH. G. W. Weir, C. L. Dodson, and W. P. Puffett (Geological Survey, Washington, D. C.). Mineral Investigations Field Studies Map MF-143. 1960. 1p.

13184 PRELIMINARY GEOLOGIC MAP OF THE MOUNT PEALE 4 SE QUADRANGLE, SAN JUAN COUNTY, UTAH, AND SAN MIGUEL COUNTY, COLORADO. Gordon W. Weir and Willard P. Puffett (Geological Survey, Washington, D. C.). Mineral Investigations Field Studies Map MF-149. 1960. 1p.

13185 PRELIMINARY GEOLOGIC MAP AND SECTION OF THE MOUNT PEALE 4 NE QUADRANGLE, SAN JUAN COUNTY, UTAH AND MONTROSE AND SAN MIGUEL COUNTIES, COLORADO. G. W. Weir, W. D. Carter, W. P. Puffett, and J. L. Gualtieri (Geological Survey, Washington, D. C.). Mineral Investigations Field Studies Map MF-150. 1960. 1p.

13186 PRELIMINARY GEOLOGIC MAP OF THE NORTHERN HALF OF THE JEFFERSON CITY QUADRANGLE, JEFFERSON AND LEWIS AND CLARK COUNTIES, MONTANA. George E. Becraft (Geological Survey, Washington, D. C.). Mineral Investigations Field Studies Map MF-171. 1960. 1p.

13187 PRELIMINARY GEOLOGIC MAP OF THE SOUTHERN HALF OF THE JEFFERSON CITY QUADRANGLE, JEFFERSON COUNTY, MONTANA. George E. Becraft (Geological Survey, Washington D. C.). Mineral Investigations Field Studies Map MF-172. 1960. 1p.

HEALTH AND SAFETY

13188 (A/AC.82/G/L.470) INFORME SOBRE MEDICIONES RADIOQUIMICAS DE LA PRECIPITACION RADIOACTIVA. (Report on Radiochemical Measurements of Radioactive Fall-Out). A. M. Martinez and S. Bulbulian (Mexico. Universidad Nacional Autónoma. Instituto de Fisica, Villa Obregon). Nov. 8, 1960. 4p.

The results obtained from the radiochemical analysis of the Sr^{90} in rain caught in a tank 1.20 m in diameter from February 1959 to June 1960 are presented. Data on the Sr^{90} content of rain water in the island of Revillagigedo in 1959 and of milk in Mexico City in June 1960 are also tabulated. (J.S.R.)

13189 (CEA-1724) EVALUATION DES RISQUES RADIOACTIFS LIES AU FONTIONNEMENT D'UNE INSTALLATION NUCLEAIRE. (Determination of Radioactive Risks Associated with the Operation of a Nuclear Plant). J. M. Lale and A. Doury (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaire, Saclay). 1960. 96p.

Numerous problems which are posed by the evaluation of the radioactive risks linked to the working of a nuclear plant are new problems that have not yet been satisfactorily solved. In these conditions this study must be considered only as a preliminary approach whose essential aims include development and synthesis of the existing data and rapid determination of conservative and usable orders of greatness for the security factors, both for normal working and in the case of an accident. The most probable typical accidents are reviewed together with the nature of the resulting risks and the principal factors on which these risks depend. Among these factors, one of the most important is atmospheric diffusion, which is studied in some detail using the analytic model by Sutton. A logical graphical presentation is made, increasing the flexibility in the use of the results and presenting the responsible authorities with a flexible, practical, and rapid means of evaluating the risks involved starting from a sufficiently general system of initial and simultaneously valid conditions (types of accident, atmospheric conditions). (auth)

13190 (CEX-59.4) AERIAL RADIOLOGICAL MONITORING SYSTEM. I. THEORETICAL ANALYSIS, DESIGN, AND OPERATION OF A REVISED SYSTEM. R. F. Merian, J. G. Lackey, and J. E. Hand (Edgerton, Germeshausen and Grier, Inc., [Las Vegas, Nev.] and Division of Biology and Medicine, AEC). July 1960. 54p.

A system analysis was made of the Aerial Radiological Monitoring Survey (ARMS) program. The objective of the analysis was to determine the feasibility of reducing the volume and the weight of the radiation-detection instrumentation and of making other possible improvements, including navigation and data reduction to yield ground-radiation-contour maps at a reduced operating cost. The present Division of Biology and Medicine–U. S. Geological Survey cooperative ARMS program is reviewed, and a philosophy of an optimum approach covering only the area of DBM interest is developed. The existing aerial radiometric measurement system is unsuitable in the light of present DBM requirements. The electronic design of a revised ARMS system is outlined in detail. Necessary modifications and accessories required with the aircraft are described. The envisioned integrated installation in a Beech Model 50E aircraft is given. Operating procedures are developed for both normal survey conditions and disaster situations. Systems error is discussed on the basis of the accuracy required with the integrated system for radiation measurements and space positioning of the aircraft. (auth)

13191 (HW-40556) SAFETY ASPECTS OF PUREX PLANT CONCENTRATOR OPERATION. J. J. Shefcik (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 23, 1955. Decl. Feb. 7, 1961. 5p.

A study was made to evaluate the possibility of an explosive reaction occurring in the Hanford Purex Plant concentrators as presently instrumented. Results revealed that the occurrence of an explosive reaction in the Purex Plant concentrators with present instrumentation is very unlikely. (W.L.H.)

13192 (MITG-408) PROGRESS REPORT ON RAND ORES FOR JANUARY 25, 1949 TO MARCH 15, 1949. John Dasher (Massachusetts Inst. of Tech., Watertown. Mineral Engineering Lab.). Mar. 15, 1949. Decl. Feb. 6, 1961. Contract W-7405-Eng-85. 11p.

Uranium may be recovered from solution by any of the following methods: a simple precipitation, three methods of obtaining iron-free precipitates, or ion exchange. MgO or calcined dolomite may be used with each of the precipitation methods. For retreatment, the precipitate may be leached with Na_2CO_3 or, after nitration, with ether, or it may be redissolved by either of two methods which reject silica. After dissolution, precipitation as peroxide, as pyrophosphate, or as hydroxide yields a high-grade product. Additional testing and economic calculations are planned to select the best method for obtaining high-grade product from Rand leach liquors. (auth)

13193 (NP-8499) HABITABILITY TEST OF THE NRDL 100-MAN SHELTER. Final Report. Robert A. Goldbeck and Paul H. Newman (American Inst. for Research, Santa Barbara, Calif.). Feb. 1960. 48p. (AIR-315B-60-FR-222).

A 14-day habitability test was conducted for an experimental 100-man fall-out shelter. The primary aim was to determine how well the shelter facilities accommodate group living and how the inhabitants adjust to shelter life. Data on shelter activities were obtained by means of closed-circuit TV and a microphone system. The shelter design, equipment, and diets tested are described. An outline is included for the organization of shelter life. It was concluded that man is physiologically and psychologically capable of remaining in a shelter like this for a two-week period. Modifications in design and equipment are suggested. (C.H.)

13194 (NP-9877) SUBMARINE HULKS AS PROTECTIVE SHELTERS. Technical Report No. 128. R. F. Swalley (Naval Civil Engineering Lab., Port Hueneme, Calif.). Feb. 21, 1961. 26p.

An investigation was made of the feasibility of using obsolete SS-212 (GATO) class submarine hulks as personnel shelters, Various schemes are considered for emplacing a submarine hulk as an underground shelter. The most

practical method is to dredge a slip into a beach area, float in the submarine, and cover it with sand. Modifications to the submarine would be necessary before it could function as a shelter. It would be necessary to install a new electrical system, a new entrance, a modified ventilation system, and a renewed airconditioning unit. The berthing facilities could be readily expanded to include 138 bunks. The overpressure capacity would be at least 267 psi, with commensurate radiation protection provided by a cover of 8 feet of sand. It is estimated that a submarine hulk could be adequately modified and emplaced for about $60,000. A breakdown of costs is given. (auth)

13195 (NP-9899) PROTECTION AGAINST CHEMICAL AND BIOLOGICAL AGENTS AND RADIOLOGICAL FALLOUT. Engineering and Design. (Corps of Engineers). Jan. 19, 1961. 72p. (EM-1110-345-461)

Fundamental principles and criteria are presented for use in the design of structures for the protection of occupants against toxicological airborne contamination. Protection from chemical and biological agents and radiological fall-out are considered. Protective considerations, operational considerations, and factors affecting occupancy are reviewed. Design criteria are included for entrances, personnel decontamination facilities, air-filter units, ventilation systems, and warning devices. Shielding fundamentals are discussed and the effectiveness of various structural materials as shielding against radiation is evaluated. Procedures for data collection and analysis are included, and correction factors are tabulated. (C.H.)

13196 (SC-4498(RR)) ENVIRONMENTAL BETA-GAMMA RADIOACTIVITY IN AIR AT SANDIA LABORATORY, FOURTH QUARTER 1960. R. E. Womelsduff and J. E. Baker (Sandia Corp., Albuquerque, N. Mex.). Feb. 1961. 11p.

A report is presented of the gross β-γ radioactivity of air samples collected during the fourth quarter of 1960. (auth)

13197 (UCRL-6323) USE OF NATURAL AIRBORNE RADIOACTIVITY TO EVALUATE FILTERS FOR ALPHA AIR SAMPLING. C. L. Lindeken (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 1961. Contract W-7405-eng-48. 16p.

Using natural airborne radioactivity as a test aerosol, a method is described which is designed to compare the surface collection efficiency of filters used for α air monitoring. (auth)

13198 (WT-1225) GAMMA RADIATION FIELD ABOVE FALLOUT CONTAMINATED GROUND. R. L. Mather, R. F. Johnson, F. M. Tomnovec, and C. S. Cook (Naval Radiological Defense Lab., San Francisco). Oct. 28, 1959. Project 2.3b of Operation TEAPOT. 93p.

Energy and direction distributions of γ photons 3.5 ft above a fall-out area were measured. The relation between fall-out γ spectra and the physical characteristics of the radiation over a uniform containment area was studied. The measurements were made with a mobile scintillation spectrometer nine days after the burst of a fission device. It is concluded that the direct unscattered radiation field, which contributes about 80% of the roentgen effectiveness, can be computed from the source strength and spectrum by simple theory requiring knowledge only of the thickness of overlying inert material. Further experiments are needed to establish the character of this overlying material and the variation of its thickness with time and other parameters. The magnitude and causes of variations in the fall-out source strength and spectrum should also be established. (C.H.)

13199 (WT-1493) CHEMICAL DOSIMETRY OF PROMPT AND RESIDUAL RADIATIONS FROM NUCLEAR DETONATIONS. George V. Taplin, Katharine M. Malin, Mary Lee Griswold, and Donald E. Paglia (California. Univ., Los Angeles). July 1960. 34p. Project 37.5 [of] OPERATION PLUMBBOB.

Chemical dosimetry studies were made to estimate human exposures to prompt and residual radiations from nuclear detonations. They included measurements of: (1) gamma radiation from fall-out at on-site and off-site areas; (2) air-dose and depth-dose distribution determinations in human phantoms placed at positions calculated to receive prompt neutron and γ-radiation exposures in the dose range of medical interest (0 to 1000 rads); and (3) estimates of γ and mixed neutron plus γ radiation exposures that might aid in the evaluation of Japanese who survived prompt-γ exposures at Nagasaki as compared with neutron plus γ exposures at Hiroshima. The feasibility of using direct-reading chemical dosimeters for estimating γ-ray exposures from nuclear fall-out and from prompt bomb γ radiations was demonstrated. The responses of single-phase dosimeters to γ rays plus neutrons provided a useful index of the total exposure because they registered the γ component accurately and also reflected the amount of associated slow- and fast-neutron radiations with sufficient accuracy (low by 10 to 25 per cent) to aid in the medical evaluation and initial segregation of radiation casualties. The present estimates regarding human median lethal (LD_{50}) doses of whole-body γ radiation, namely, about 350 r for multidirectional exposures from fall-out and about 450 r for unidirectional prompt-γ exposures, are in accord with each other on the basis of depth-dose distribution results and integral-dose calculations. On the same basis, the LD_{50} dose for a mixed neutron-γ ray exposure in equal amounts should be about 450 rads or less, depending on the relative biological effectiveness (RBE) values used for neutrons. Further biological investigations are needed in large animals to obtain RBE values for neutron exposures at various energy levels. Dosimeters suitable in respect to size, stability features, and radiation characteristics need to be developed to obtain further information on the distribution of mixed radiations in tissue-equivalent phantoms and in large animals. (auth)

13200 RADIATION PROTECTION ORDINANCE AND WATER SUPPLIES. J. Holluta (Technische Hochschule Karlsruhe). Atomwirtschaft, 2: 113-16(Feb. 1961). (In German)

The protection of water supplies from radioactive contamination is one of the most important concerns of the first Radiation Protection Ordinance of the German Federal Republic. Since comprehensive measures at the waterworks appear impracticable, they must be enforced at the places at which radioactive material is deposited. Although the obligations on those concerned are, in some sections, considered to be too stringent, the water industry holds them as absolutely necessary because of the strong legal responsibility for the supply of unexceptionable water. (auth)

13201 BASES FOR ESTABLISHING NUCLEAR-SAFETY CRITERIA. Norman Ketzlach (General Electric Co., Richland, Wash.). Chem. Eng. Progr., 56: Symposium Ser. No. 28, 46-50(1960).

A method of analysis is presented which may be used to determine nuclear safety of arrays based on mass limitations, mass-per-unit-area limitations for single infinite plane arrays, and mass-per-unit-length for arrays in the form of cylinders (tube bundles of fuel elements). (auth)

13202 A CHEMICAL METHOD FOR NUCLEAR REACTOR DECONTAMINATION. John L. Zegger and Guyon P. Pancer (Alco Products, Inc., Schenectady, N. Y.). Chem. Eng. Progr., 56: Symposium Ser. No. 28, 66-71(1960).

The use of an alkaline permanganate-citrate treatment affords an excellent means of decontaminating Type 304 stainless steel surfaces. Decontamination factors greater than 20 are obtained with corrosion rates less than .01 mil penetration. Flow rate and temperature are found to be important parameters for successful decontamination. (auth)

13203 THE DESIGNING OF LABORATORIES AND RADIATION SAFETY. V. P. Granilshchikov and G. M. Parkhomenko. Med. Radiol., 5: No. 12, 47-56(Dec. 1960). (In Russian)

Data are given as pertinent to the importance of designing of laboratories for work with radioactive substances in the problem of securing radiation safety for research workers. Examples are given of zonal designing in accordance with the sanitary requirements. (auth)

13204 DETERMINATION OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF P^{32} BETA RADIATION. T. Rudnicki. p.754-6 of "Pierwsze Krajowe Sympozjum Poswiecone Stosowaniu Izotopow Promieniotworczych W Biologii, Medycynie, I Rolnictwie, 2 i 3 Kwietnia 1959, Warszawa." Warsaw, Bureau of the Atomic Energy Ministry, 1959. (In Polish)

The comparison of the biological effectiveness of P^{32} β radiation and 70-kev γ radiation was made for three biological specimens; the specimens were fruit fly eggs, pea sprouts, and the tops of the sprouts of Vi. faba. A large number of batches of fruit fly eggs, specially prepared and incubated, were irradiated with 70-kev x rays and P^{32} betas. One set of batches was irradiated after 1 hr of incubation and another set after 3 hr. The number of irradiated eggs hatched after 48 hr was in each case compared with an unirradiated control batch. A plot of fatality vs. dose was thus obtained for each case. The 1-hr incubated eggs were much less resistant to radiation than the 3-hr eggs. A value of 1.0 for the RBE of P^{32} betas was obtained with the former and 0.85 with the latter by comparing the β and x ray doses required to produce a 50% fatality. The statistical uncertainty of these two determinations did not clearly establish that the RBE for P^{32} betas was different from 1.0. It did, however, in measurements of rate of growth of the sprout specimens. The doses required to reduce the rate of growth by 50% yielded a value of RBE of 0.6 for both pea sprouts and the tops of the sprouts of Vi. faba. It is concluded that the value of RBE depends on experimental conditions as well as on the biological specimen, that extreme care must be taken in any attempts to carry over results with biological specimens to the realm of human pathology, and that concrete experimental conditions must be chosen and clearly stated in determining the RBE in biological radiation-damage studies as well as in medicinal methods. (TTT)

13205 PRINCIPLES OF RADIATION AND CONTAMINATION CONTROL. VOLUME TWO. PROCEDURES AND GUIDELINES RELATING TO NUCLEAR WEAPON EFFECTS. R. A. Sulit, E. J. Leahy, and A. L. Baietti (Naval Radiological Defense Lab., San Francisco, Calif.). 1960. 350p. (NAVSHIPS-250-341-3(Vol. II))

Principles and procedures are outlined for the control of radiation exposure due to nuclear weapons. Necessary background and technical knowledge is included which will be needed by those training radiological monitors. Topics discussed include sources of ionizing radiations, the basic science and fundamentals of radiological safety, monitoring procedures, and maximum permissible limits for controlled and special operations. Satisfactory instruments and methods for field measurements are described in detail. Miscellaneous data and analytical procedures are appended. (C.H.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

13206 (AFOSR-TN-113) SURFACE STUDIES IN ULTRAHIGH VACUUM BY RADIOTRACER TECHNIQUES. E. Von Goeler (Air Force Office of Scientific Research, Washington, D. C.). Jan. 1961. Contract AF18(603)-49. 76p.

Activities are reported in a research program to develop radiotracer methods of monitoring amounts of adsorbed matter on the clean surfaces used in studies of atomic or molecular interactions with such surfaces. The interactions of a silver beam with polycrystalline molybdenum and nickel surfaces are studied, and a model of the surface and surface interactions is presented. It is noted that in the experiments, the possibilities of surface impurities are reduced but not eliminated. It is also noted that no selection of desorption mode can be made until further studies using single crystal substrates are made. (J.R.D.)

13207 (JLI-650-6-3) THE DEVELOPMENT OF PRINCIPLES AND METHODS OF HIGH DILUTION ON-STREAM ISOTOPIC TRACERS. (In Situ Tracer Project). Annual Report. William H. Johnston, A. F. Findeis, Marvin L. Vestal, H. R. Fechter, Paul E. Pontius, Konrad Benford, Diana River, and Morton Palmer (Johnston (William H.) Labs., Inc., Baltimore). May 1960. Contract AT(11-1)-650. 146p.

The investigation was designed to follow five broad approaches to the development of on-stream in situ tracer methods, principles, and techniques, which include theoretical studies, β and γ counting, and electronics, with emphasis on transistor principles and applications. Phase I was to identify and evaluate previous work accomplished in stream tracer studies and relate present research and development thereto. Phase II envisioned exploration, in-depth technical analysis, and development of methods and principles for the application of in situ tracers, to problems such as (a) tracing the sources of stream pollution from civil and industrial waste disposals; (b) the use of natural radiocarbon as an indication of the source of organic pollutants; (c) tracing the in-stream movements and attendant chemical and physical changes of certain waste compounds upon discharge to the river; (d) tracing the mechanisms of formation and of subsequent stream pollution by natural wastes such as the sulfur acids from coal mine drainage; (e) tracing river flow patterns, and in particular the measurement of longitudinal eddy diffusion coefficients and lateral mixing; and (f) relating the methods and techniques to industrially oriented problems. When necessary to demonstrate feasibility, laboratory mock-ups of the systems were applied in appropriate field tests. In particular, laboratory mock-ups of the low-level counting systems were applied to the feasibility demonstrations of source identification of certain pollutants of the Ohio River. The theoretical discussions include low-level counting theory and the development of nomographs, a generalized case of large-scale pulse injection, and planning nomographs for tracer experiments, including design principles for high-dilution tracer applications in rivers and streams. (auth)

13208 (NP-9511) PRESERVAÇÃO DE ALIMENTOS POR MEIO DA RADIAÇÃO. (Preservation of Food by Means of Radiation). L. O. B. Aghina and B. Chimbleris. (Brazil. Comissão Nacional de Energia Nuclear.) 1958. 10p. (EBR/PA-1)

The destruction of food by different organisms is described and methods of preventing this destruction are outlined and compared with the radiation method. A survey is made of the various sources available for food processing. (T.R.H.)

13209 (NP-9526) USES OF RADIOISOTOPES IN THE TEXTILE INDUSTRY. A SELECTED BIBLIOGRAPHY. T. I. S. Report No. 54. L. L. Covert (National Research Council of Canada, Ottawa). May 1959. 9p.

Most of the articles included deal directly with the use, or possible use, of radioisotopes in the textile field. A few references to books and articles that discuss the types of radiation produced by various isotopes, the precautions that should be taken in handling isotopes, etc., are included. Three articles discuss laundering techniques; they may be of interest to workers in this general field. (W.L.H.)

13210 (NYO-9039) THE STUDY OF THE POTENTIAL APPLICATIONS OF RADIOISOTOPE TECHNOLOGY TO WATER RESOURCE INVESTIGATIONS AND UTILIZATION. Quarterly Report No. 3. Herbert W. Feely (Isotopes, Inc., Westwood, N. J.). Jan. 31, 1961. Contract AT(30-1)-2477. 89p.

A review was made of all work done on the application of radionuclear techniques to research in water resources and supply. The work is evaluated, and specific experiments are suggested which must be performed if these applications are to be extended. A literature search was continued. Information gathered on the application of radionuclides to particular problems or in particular fields is given in Appendixes A through E. Appendix A contains a short review of the usefulness of boron compounds as tracers for water. Appendix B contains a summary of the factors that affect the C^{14} content of subsurface waters. The conclusion is reached that analyses of the C^{14} concentration in the dissolved bicarbonate in samples of ground water could often provide data useful for determining the source and history of the water. A summary of the present applications of radionuclear techniques to the measurement of soil-moisture contents and an outline of the potential usefulness of radioisotopes for tracing soil moisture are presented in Appendix C. A suggested experimental program for the determination of the feasibility of such tracing is included in the appendix. The need for the development of techniques whereby neutron activation may be used to measure stable elements used as water tracers is discussed in Appendix D. An experimental program whereby the feasibility of such tracing might be tested is also suggested. Appendix E contains a discussion of the principles

involved in the stabilization of tracer nuclides in solution through the use of chelating agents. Some past uses of chelated tracers are reviewed, and the prospects for the development of still better tracers through this technique are evaluated. (C.H.)

13211 (TID-11306) EXPLORATION OF RADIOMETRIC METHODS FOR INDUSTRIAL PROCESS CONTROL. Final Report. William J. Driscoll, Benjamin F. Scott, and Edmund A. Huff (Nuclear-Chicago Corp., Des Plaines, Ill.). Feb. 28, 1961. Contract AT(11-1)-695. 67p.

A survey was conducted of various beta emitting isotopes that may have possible application in a radiometric analysis. Approximately one-third of the elements of the periodic table can be determined, using this technique. Experimental work was carried out on the determination of the following ions: chloride, bromide, iodide, chromate, and cyanide ions using silver-110; chloride using mercury-203; barium and lead using sulfur-35; fluoride using calcium-45; zinc and manganese using phosphorus-32. A variation of the radiometric equation can be applied for the determination of nickel using nickel-63 and for sulfate using sulfur-35. The radiometric analysis principle was applied to the development of a centrifuge-counter to perform the analyses semi-automatically or automatically. It consists of a spinning cylinder within which there is a stationary thin-walled beta detector. The precipitation reaction is carried out and the slurry is applied to the inside wall of the spinning cylinder. The solid precipitate migrates to the wall where it is covered by a layer of solution sufficiently thick to shield the detector from the radioactivity of the precipitate. The resulting count rate will largely represent that of the supernatant solution only. Present development of the centrifuge counter is limited to the semi-automatic stage. (auth)

13212 (CEA-tr-R-254) MESUREUR RADIOACTIF DE L'EPAISSEUR POUR LE CONTROLE CONTINU, SANS CONTACT, D'UNE BANDE DE VERRE EN COURS DE LAMINAGE. (Radioactive Thickness Gage for Non-Contact Continuous Inspection of Glass Strips during Rolling). O. P. Nikotin and D. A. Leshchinskii (Leshchinsky). Translated into French from Steklo i Keram., 16: No. 7, 35-7(1959). 7p.

A radioactive gage to measure automatically and continuously the thickness of a glass strip during rolling was designed. A sketch of the instrument is given. The operation of the apparatus is based on the scattering of γ rays by the glass. The intensity of the scattered radiation, recorded by counters, is an almost linear function of the thickness of the glass. Preliminary studies have shown that the intensity of the scattered radiation has a wide maxima so that the distance between the source and the glass strip is not critical. Ir^{192} was used as the gamma source. (J.S.R.)

13213 (NP-tr-577) PROSPECTS OF THE REALIZATION OF RADIATION CHEMICAL PROCESSES IN THE CHEMICAL INDUSTRY. M. A. Proskurnin. Translated from Khim. Prom. No. 2, 7-14(1959). 21p.

The features of radiation effects which are basically different from the effects of other agents and which are of interest to chemical technology are discussed. The nature of radiochemical reactions in pure substances is explored in terms of free radicals and atoms with polymerization as a particular example. Ionic and graft polymerizations are considered as methods of producing new compounds where ordinary polymerization fails. Two processes take place in an irradiated solid polymer: (1) hydrogen atoms split off from adjacent molecules, resulting in crosslinking; (2) rupture of C–C bonds and oxidation occur, resulting in degradation. Radiation vulcanization is discussed as a means of improving the properties of rubber. The formation and freezing of radioinduced free radicals are briefly discussed. Radiation effects in mixtures are also treated. In dilute solutions, only the solvent reacts with radiation in appreciable quantities, but the dissociation products may then react with the solutes and thus produce an indirect radiation effect. The case of H_2O as a solvent and the method of conjugate reactions in which two substances are introduced into the aqueous solution, one reacting with the H atoms and the other with the OH radicals, are considered. As an example, the oxidation of benzene to phenol in the presence of H_2O is discussed. Other applications of radiation are discussed, e.g., oxidation, dyeing, and catalysis. The economic feasibility of using such radiation effects on an industrial scale is discussed from the standpoint of sources of nuclear energy and the problem of irradiating the substance to be treated and then decontaminating it; the feasibility is concluded to be low at the present time. (D.L.C.)

13214 RADIOTRACER STUDY OF FLOW PATTERNS IN A FLUID COKER. J. M. Ausman, A. Beerbower, and R. E. Olsen (Esso Research and Engineering Co., Linden, N. J.). Chem. Eng. Progr., 56: Symposium Ser. No. 28, 72-5(1960).

Radiotracers are successfully employed to determine flow patterns, mixing uniformity, and oil-feed dispersion in the fluidized bed of an operating commercial fluid coker. A direct external measurement rather than a sample removal technique is used even though no calibration readings are available. (auth)

13215 MEASUREMENT OF GEAR WEAR BY ACTIVATING WEAR PARTICLES IN THE LUBRICANT. Harvey D. Briggs and John F. Coultry (General Electric Co., Schenectady, N. Y.). Chem. Eng. Progr., 56: Symposium Ser. No. 28, 76-8(1960).

Neutron-activation analysis provides a method in which the high sensitivity of radioactive measurement techniques can be obtained without the introduction of radioactive material into the test system or factory area. The application of this technique to the measurement of gear wear in a lubricating system eliminates the necessity for handling material or equipment in the radioactive form. Small samples of the lubricant containing gear-wear particles are activated by neutron bombardment, and the resultant activity is analyzed for the amount of one trace element with a gamma spectrometer. Quantitative measurements of the gear wear are made by comparing the oil samples with a calibrated sample containing a known amount of the gear material. With this method, gear-wear curves can be obtained in a short test period. (auth)

13216 A BETA-RAY SOURCE FOR LIQUID-DENSITY MEASUREMENT. Edward J. Freeh and Clyde H. Kearns (Industrial Nucleonics Corp., Columbus, Ohio). Chem. Eng. Progr., 56: Symposium Ser. No. 28, 79-83(1960).

The advantages presented by techniques utilizing beta-radiation adsorption for the accurate measurement of liquid densities are described. The fraction of radiation transmitted may be correlated with sample density and composition through an exponential relation employing relative absorption cross sections. (auth)

13217 A RADIOMETRIC METHOD FOR VISCOSITY MEASUREMENTS. V. D. Goroshko and Yu. P. Gupalo (Inst. for Fossile Fuels, Academy of Sciences, USSR). Zavodskaya Lab., 27: 38-40(1961). (In Russian)

A method based on the measurement of velocity of the fall of a ball containing a radioactive isotope, such as Co^{60}, Zn^{65} or Sn^{113} was used for determining the rheological

properties of suspensions. Other isotopes may be also used, as long as the energy of their γ radiation is more than 80 kev and they can be fabricated in the form of powder or wire. Activities of about 30 to 40 microcuries were used for labeling a single ball. The viscosity values agreed quite well with control tests performed with a rotating cup viscometer. A scintillation counter and a photomultiplier tube were used for determining the location of the ball. The optimum depth for the radiation collimator was calculated at about 62% of the vertical path of the fall of the ball. (TTT)

13218 IMPROVEMENTS IN OR RELATING TO NUCLEAR ENERGY. (to Societe Belge de L'Azote and Produits Chimiques du Marly). British Patent 861,640 Feb. 22, 1961.

A chemical reactor is designed for carrying out reactions in the gaseous phase using energy produced by nuclear fission. The reactor comprises a flow conduit for the gaseous reactants which contains a plurality of transverse perforated baffles. The baffles are coated with a fissionable material, preferably by covering the baffles with a solution of nitrocellulose and uranyl nitrate, heating to ~ 500°C to burn off organic deposits and to convert the uranium into U_3O_8, and then heating in hydrogen at ~ 250°C to reduce U_3O_8 to UO_2. (D.L.C.)

ISOTOPE SEPARATION

13219 (TID-11024) MERCURY-204 PHOTOCHEMICAL SEPARATION PROGRAM. Phase 1, Final Report. David B. Cooper and Norman P. Otto (Thompson Ramo Wooldridge Inc., Cleveland). Aug. 29, 1960. Contract AT(33-3)-10. 23p. (ER-4168).

An investigation was made of the feasibility of extracting Hg^{204} from natural mercury by means of a photochemical separation technique. The work accomplished included: (1) design of a pilot plant having an electroded vapor lamp as the source of resonant radiation; (2) construction of the pilot plant; (3) conducting test runs with varying operating parameters; and (4) consideration of the data gathered. During all test runs the desired chemical product (mercuric oxide) was obtained. Isotopic analysis of the product indicated that Hg^{204} enrichment occurred in a majority of the test runs. Theoretical efforts, coupled with the knowledge gained through the test program, resulted in a modified pilot plant concept which is expected to provide Hg^{204} enrichments of a much greater magnitude than achieved in the initial pilot-plant configuration. (auth)

13220 (CEA-tr-A-797) PROCEDE D'ENRICHISSEMENT EN DEUTERIUM PENDANT LA MARCHE DE REACTEURS MODERES ET REFROIDIS A L'EAU. (Process for Enrichment of Deuterium During Operation of Reactors Cooled and Moderated by Water). H. Maier-Leibnitz. Translated into French by R. Carbonnier from German Patent 1,054,429. 8p.

A process is given for obtaining deuterium-enriched hydrogen or water from a homogeneous or semihomogeneous reactor. The radiolytic gases are catalytically recombined; but the light hydrogen combines at a faster rate than the heavy, leading to an enrichment in the residual radiolytic gases. These residual gases are led to a gas separator and removed, fresh water being added as a replacement. (T.R.H.)

13221 (CEA-tr-A-800) METHODE DE PREPARATION DE L'EAU LOURDE. (Method of Preparation of Heavy Water). O. Hirzel and B. Storsand. Translated into French from Swiss Patent 332 465. Oct. 31, 1958. 4p.

A method for the production of heavy water during the preparation of hydrogen by electrolysis is presented. The feed water for the electrolytic decomposition is enriched with heavy water obtained by fractional distillation in cascade. The heat necessary is furnished in part by the heat produced in the electrolysis. The hydrogen produced in the electrolysis is liquefied, and the deuterium is separated by distillation. It is then converted into heavy water by combustion. (J.S.R.)

13222 (CEA-tr-A-801) METHODE DE PREPARATION DE L'EAU LOURDE. (Method of Preparation of Heavy Water). O. Hirzel and B. Storsand. Translated into French from Swiss Patent 332 467. Oct. 31, 1958. 4p.

A method for the preparation of heavy water is presented which combines the electrolytic and thermal methods of hydrogen production. The feed water, enriched by electrolysis with heavy water, is used for the thermal production of hydrogen. The hydrogen obtained by the thermal process is liquefied. Deuterium is separated from the liquid and converted into heavy water by combustion. (J.S.R.)

13223 (CEA-tr-R-1003) METHODES DE SEPARATION D'ISOTOPES RADIO-ACTIFS AVEC UTILISATION DU PHENOMENE DE LA FORMATION DE COMPLEXES. (Methods of Separation of Radioisotopes Using the Phenomenon of Complex Formation). N. P. Rudenko (Roudenko). Translated into French from Zhur. Neorg. Khim., 1: 1091-1103(1956). 32p.

The use of complex formation in radiochemical preparation of isotopes is discussed. The various processes in which complex formation plays a part are considered separately: precipitation and leaching, formation of radiocolloids and adsorption, chromatography, solvent extraction, and electrolysis. (T.R.H.)

13224 THE ISOTOPIC EXCHANGE OF OXYGEN BETWEEN IODATE IONS AND WATER. M. Anbar and S. Guttmann (Weizmann Inst. of Science, Rehovoth, Israel). J. Am. Chem. Soc., 83: 781-3(Feb. 20, 1961).

The isotopic exchange of oxygen between iodate ions and water was studied in the pH range of 4.5 to 10.5. The reaction was found to be both acid and base catalyzed. The rate of exchange R = moles/liter/sec can be expressed by $R = 3.24 \times 10^4 (H^+)(IO_3^-) + 1.35 \times 10^3 (OH^-)(IO_3^-)$ at 25°. The suggested mechanism of exchange is via the reactions $H_2IO_4^- \rightleftharpoons IO_3^- + H_2O$ and $OH^- + HIO_4^{2-} \rightleftharpoons OH^- + HIO_4^{2-}$. General acid and general base catalysis was observed. The general base catalysis is expressed by the equation $HIO_4^{2-} + B \rightleftharpoons BIO_3^- + OH^-$. The formation of complexes of the type BIO_3^- is postulated, where B = ammonia, pyridine, cyanide, borate, urea, acetate, and fluoride. (auth)

13225 HIGH CONCENTRATION–RATIO EXPERIMENTS: ISOTOPE FRACTIONATION AT THE METHYL CARBON IN THE REACTION OF CYANIDE ION AND METHYL IODIDE. ISOTOPE EFFECT UNDER CONDITIONS OF EQUAL REAGENT CONCENTRATIONS. K. R. Lynn and Peter E. Yankwich (Univ. of Illinois, Urbana). J. Am. Chem. Soc., 83: 790-3(Feb. 20, 1961).

The C^{13} isotope effect for isotopy at the methyl carbon atom was measured in the cyanization of methyl iodide in water solution between 11.4 and 58.0°. As a check on these results and those previously reported for isotope fractionation at the cyanide carbon atom, experiments were carried out also in which the reagents were present at equal concentrations instead of one being in large excess; the check experiments yield data of considerably higher quality than either set obtained under high-concentration-ratio conditions. There is general agreement among the three sets of results, but it is not sufficiently close to permit detailed speculations concerning the nature of the reaction coordinate motion in terms of simple models. The methyl carbon isotope effect in the cyanization is much larger than that observed in the related hydrolysis, a fact which cannot be explained unless account is taken of the details of activation changes in C–H bonding. (auth)

13226 FRACTIONATION OF NITROGEN ISOTOPES BETWEEN NITROSONIUM SALT SOLUTIONS AND NITROGEN OXIDES. Alfred Narten (Columbia Univ., New York). J. Chem. Phys., 34: 1056-7(Mar. 1961).

Single stage enrichment factors α for the isotope exchange reaction of N^{15} between oxides of nitrogen and solutions of nitrosylsulfuric and nitrosylphosphoric acid are determined. Single-stage equilibration resulted in values of α that decrease from 1.046 for 1M to 1.013 for 10.2M sulfuric acid in the nitrosylsulfuric acid system and from 1.042 for 4.7M to 1.005 for 14.8M phosphoric acid in the nitrosylphosphoric acid system. (auth)

MATHEMATICS AND COMPUTERS

13227 (APEX-582) ELECTRON DIFFUSION PARAMETERS. J. R. Beeler and M. R. Smith (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Dec. 1958. 20p. Contracts AF33(600)-38062 and AT(11-1)-171.

An IBM 704 computer program which computes diffusion parameters for the dispersal of electrons in an infinite homogeneous medium is described. These parameters are the diffusion-onset energy, the straight-line distance between the source point and the point at which diffusion begins, the total track length between the source point and the diffusion-onset point, and the diffusion area to a specified cut-off energy. (auth)

13228 (NYO-9488) AN ALGORITHM FOR CONSTRUCTING FEASIBLE SCHEDULES AND COMPUTING THEIR SCHEDULE TIMES. Jack Heller and George Logemann (New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center). Nov. 15, 1960. 30p.

An algorithm for the generation of feasible schedules and the computation of the completion times of the job operations of a feasible schedule is presented. Using this algorithm, the distribution of schedule times over the set of feasible schedules—or a subset of feasible solutions—was determined for technological orderings that could occur in a general machine shop. These distributions were found to be approximately normal. Biasing techniques corresponding to "first come first serve," random choice of jobs ready at each machine and combinations of these two extremes were used to compute distributions of schedule times. In all the experiments first come first serve appeared the best in the sense that convergence to the minimum is fastest and the sample minimum is the smallest. (auth)

13229 (SCR-285) DISTRIBUTION FREE TOLERANCE LIMITS FOR AN ADDITIONAL FINITE SAMPLE AS OBTAINED FROM THE HYPERGEOMETRIC DISTRIBUTION. D. B. Owen (Sandia Corp., Albuquerque, N. Mex.). Feb. 1961. 12p.

Distribution-free tolerance limits on any continuous population are reviewed. Distribution-free tolerance limits on an additional sample of m observations, given an initial sample of n observations, are then considered. Formulas are given for the proper probability statement regarding the additional m observations in order to obtain the probability from tables of the hypergeometric probability distribution. (auth)

13230 (SCTM-35-61(72)) A TIME-BASED ANALYSIS OF GMD-1 DATA FOR ELECTRONIC COMPUTERS. R. L. Levesque (Sandia Corp., Albuquerque, N. Mex.). Feb. 1961. 10p.

Installation of a time-marking pen on the AN/TMQ-5 recorder makes possible a time-based analysis of GMD-1 raw data. This analysis eliminates the inherent timing and interpolation errors of the present system, simplifies the computer program, and speeds the reduction of the data. (auth)

13231 (SCTM-65-60(14)) A STATISTICAL APPROACH TO TOLERANCES. A. M. Breipohl (Sandia Corp., Albuquerque, N. Mex.). Mar. 22, 1960. 35p.

Both out-of-tolerance and complete failures are observed in equipment used at Sandia Corporation. In present reliability evaluations, however, the out-of-tolerance types of failures were loosely grouped with complete failures and have been analyzed by the usual failure probability equations. This memorandum offers a parallel method for the study of out-of-tolerance failures, which are considered as important as the usual failure probability equations. The statistical methods presented here can be used to evaluate the effects of out-of-tolerance failures upon the reliability of the device in question and to reduce the occurrence of this type of failure. No claim is made for the uniqueness of the methods presented. The specific methods and examples, however, represent a simple but inclusive procedure that has direct application to reliability problems. (auth)

13232 (SRB-60-11) CHARACTER RECOGNITION DEVICES FOR ELECTRONIC COMPUTERS. An Annotated Bibliography. K. D. Carroll, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Nov. 1960. 96p.

The literature covering theory, design, equipment, and applications of machines that perceive, learn, think, and make reasonable inferences, or learn to perform acts of skill, is presented. These include learning machines, reading machines, and machines capable of speech recognition. The period is primarily from 1954 to the present. 311 references. (auth)

13233 (TID-11142) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. CIRCUIT RESEARCH PROGRAM. PART III. MATHEMATICAL METHODS. PART IV. SWITCHING CIRCUIT THEORY. PART V. ILLIAC USE AND OPERATION. PART VI. IBM 650 USE AND OPERATION. PART VII. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). March 1960. 39p. Contract AT(11-1)-415.

Developments in the high-speed computer program, circuit research, mathematical methods, and switching circuit theory are summarized. Illiac and IBM-650 use and operation are detailed. (See also TID-11192.) (W.D.M.)

13234 (WAPD-TM-226) CURF1—A LEAST-SQUARES POLYNOMIAL FITTING PROGRAM FOR THE PHILCO-2000. A. V. Pace (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1961. Contract AT-11-1-GEN-14. 11p.

CURF-1 determines the real coefficients of a polynomial which best fits a given set of data points in the sense of least squares. The program evaluates the polynomial at specified points and computes the deviation of the polynomial from the original points. CURF-1 computes the first derivative at each point, the standard deviation of the estimate, and the maximum absolute error. (auth)

13235 (WAPD-TM-238) INPUT PREPARATION FOR DIFFUSION-DEPLETION PROGRAMS ON THE PHILCO-2000 COMPUTER. W. R. Cadwell and H. P. Henderson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1961. Contract AT-11-1-GEN-14. 14p.

Features of input preparation are described which were standardized in a diffusion depletion program package for

the Philco-2000 computer. Programs included are WANDA, CANDLE, ZIP-2, PDQ-4, TURBO, and TNT-1. (J.R.D.)

13236 (AEC-tr-4426) THE RIEMANN AND HILBERT BOUNDARY PROBLEMS SINGULAR INTEGRAL EQUATIONS. Translated by J. F. Heyda from selected topics from the Russian text "Kraevye Zadaci" ("Boundary Problems") by F. D. Gahov, (Moscow, 1958). 59p. (XDC-60-9-30)

An introduction to the theory of the Riemann and Hilbert boundary problems and their application to the solution of singular integral equations with Cauchy and Hilbert kernels are given. Topics discussed include definition and limiting values of Cauchy type integrals, Hilbert formulas for the boundary values of the real and imaginary parts of an analytic function, definition and fundamental properties of Riemann's boundary problem, singular integral equations with Cauchy kernel, definition of Hilbert boundary problem, relation between the Riemann and Hilbert boundary problems, and singular integral equations with Hilbert kernel. (M.C.G.)

13237 (JPRS-7491) DIGITAL TECHNIQUE AND COMPUTING DEVICES. Translated from Tsiforovaya Tekhnika i Vychislitel'nyye Ustroystva, Moscow, 1959. 263p.

Papers devoted to digital techniques are incorporated into a first collection by the Institute of Electronic Control Computers of the USSR Academy of Sciences. A ferrite storage unit with a capacity for 4090 36-place binary numbers built to replace the electrostatic-tube storage unit of the M-2 computer is described. Methods of selecting the core and of tuning a ferrite memory are discussed. The various applications of transistors in digital devices are outlined. The stability of electronic analog computers was investigated. The determination of the mutual and self-impedances of the computer's complex electric circuits is discussed. The principles of devices that convert electrical quantities into digital code are reviewed. Experimental data on the durability of various components of the machine are reported. (M.C.G.)

13238 MADCAP: A SCIENTIFIC COMPILER FOR A DISPLAYED FORMULA TEXTBOOK LANGUAGE. Mark B. Wells (Los Alamos Scientific Lab., N. Mex.). Communs. Assoc. for Computing Machinery, 4: No. 1, 31-6(Jan. 1961).

A discussion is presented of some of the unique features of a compiler for scientific problems which was designed at Los Alamos for the MANIAC II computer. The compiler, MADCAP, is an attempt to eliminate the disparity between the textbook presentation of a problem and that presentation which serves as input for a compiler. (T.R.H.)

13239 SELECTED BIBLIOGRAPHY OF STATISTICAL LITERATURE, 1930 TO 1957. [PART] IV. MARKOV CHAINS AND STOCHASTIC PROCESSES. Lola S. Deming and D. Gupta (Catholic Univ. of America, Washington, D. C.). J. Research Natl. Bur. Standards, 65B: No. 1, 61-93(Jan.-Mar. 1961).

A bibliography is presented on Markov chains and stochastic processes. Zentralblatt für Mathematik (1930-1940) and Mathematical Reviews (1940-1957) provided the source material. (about 1200 references). (T.R.H.)

13240 ON THE CONNECTION BETWEEN VARIOUS DERIVATIONS OF THE BOLTZMANN EQUATION. E. G. D. Cohen (Universiteit, Amsterdam). Physica, 27: 163-84(Feb. 1961). (In English)

The connection between a number of derivations of the Boltzmann equation from the Liouville equation is investigated. In particular it is shown that the time-smoothed second distribution function, used by Kirkwood in his derivation of the Boltzmann equation, is identical with that obtained by Bogulubov by a systematic expansion in the two parameters $1/v$ (density) and μ (uniformity) and keeping terms of $O(1/v)$ and of $O(\mu)$. This leads not only in both cases to the Boltzmann equation but also to identical correction terms of $O(\mu)$ on this equation. A similar analysis is carried out as regards to the derivations of Yvon, Born and Green, Hollinger and Curtiss, Schönberg and Frisch. Contrary to the methods of Bogolubov and Kirkwood, these derivations do not, however, introduce explicitly or correctly coarse-grained distribution functions. (auth)

13241 MULTIPLE INPUT BINARY ADDER EMPLOYING MAGNETIC DRUM DIGITAL COMPUTING APPARATUS. E. H. Cooke-Yarborough (to U. S. Atomic Energy Commission). U. S. Patent 2,963,223. Dec. 6, 1960.

A digital computing apparatus is described for adding a plurality of multi-digit binary numbers. The apparatus comprises a rotating magnetic drum, a recording head, first and second reading heads disposed adjacent to the first and second recording tracks, and a series of timing signals recorded on the first track. A series of N groups of digit-representing signals is delivered to the recording head at time intervals corresponding to the timing signals, each group consisting of digits of the same significance in the numbers, and the signal series is recorded on the second track of the drum in synchronism with the timing signals on the first track. The multistage registers are stepped cyclically through all positions, and each of the multistage registers is coupled to the control lead of a separate gate circuit to open the corresponding gate at only one selected position in each cycle. One of the gates has its input coupled to the bistable element to receive the sum digit, and the output lead of this gate is coupled to the recording device. The inputs of the other gates receive the digits to be added from the second reading head, and the outputs of these gates are coupled to the adding register. A phase-setting pulse source is connected to each of the multistage registers individually to step the multistage registers to different initial positions in the cycle, and the phase-setting pulse source is actuated each N time interval to shift a sum digit to the bistable element, where the multistage register coupled to bistable element is operated by the phase-setting pulse source to that position in its cycle N steps before opening the first gate, so that this gate opens in synchronism with each of the shifts to pass the sum digits to the recording head.

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

13242 (59-RL-2294M) AN EVALUATION OF PROCEDURES IN QUANTITATIVE METALLOGRAPHY. I. VOLUME-FRACTION ANALYSIS. J. E. Hilliard and J. W. Cahn. (General Electric Co. Research Lab., Schenectady, N. Y.). Oct. 1959. 28p.

Calculations were made of the standard deviations to be expected in the measurement of volume fractions by areal and lineal analysis four point-counting procedures. The effect of experimental errors is not included. Provided each method of analysis is used under its optimum conditions, the standard deviation is found to be principally determined by the number of observations made on the phase; it makes little difference whether the observation be a measurement of an intercepted area or length or the identification of the phase occupied by a point. If the phase to be estimated occurs as discrete particles randomly dispersed, then, for a given number of observations, two forms of systematic point counting have, surprisingly, a smaller standard deviation than either a lineal or an areal analysis. It was concluded that a systematic point count using a two-dimensional grid is the most efficient method of volume fraction analysis. However, to preserve this efficiency, it is essential that the spacing be such that the number of occupied points should not greatly exceed the number of structural features lying under the grid. (auth)

13243 (BM-RI-5734) PRODUCTION OF BIMETAL-REDUCED HAFNIUM. Dale W. Richardson (Bureau of Mines, Albany, Oreg.). May 1959. 24p.

Since it was desired to produce hafnium ductile enough for rolling into strips, experiments were performed in which $HfCl_4$ produced from HfO_2 was reduced in different ways. The conventional (Kroll) way using magnesium gave hafnium of high oxygen content which could not be rolled. Bimetal reduction using sodium and magnesium gave better recoveries of hafnium with low oxygen content (800 ppm); $HfCl_4$ evaporation from fused NaCl–KCl during bimetal reduction lowered the aluminum content in hafnium produced from $HfCl_4$ made from HfO_2 of high aluminum content (>1200 ppm). Sponge from nine fused-salt bimetal reduction runs was melted into ingots and rolled into strips. However, the strips were frequently microporous and four had a hardness exceeding the maximum allowable hardness of Rockwell A 58 (R_c 20). (D.L.C.)

13244 (GAMD-1178) PREPARATION OF UC_2–ThC_2–GRAPHITE FUEL BODIES FOR THE GA-308-3 AND GA-308-4 HTGR CAPSULE IRRADIATIONS. R. Pyle and J. Pontelandolfo (General Atomic Div. of General Dynamics Corp., San Diego, Calif.). Jan. 15, 1960. 24p. Project No. 32-Task No. 32.110. Contract No. AT(04-3)-314.

The preparation of the fuel bodies for the GA-308-3 and GA-308-4 capsule irradiations is described. They are annular, dispersion type bodies of the kind being developed for the HTGR and consist of thorium–uranium carbide particles in a graphite matrix. A comparison of the capsule fuel bodies with the HTGR fuel bodies is given. Two sets of fuel bodies were prepared for the capsule irradiations. One set was made starting with solid solution thorium–uranium oxide fuel (for GA-308-3). The second set was made from thorium–uranium–silicon alloy fuel (for GA-308-4). In each case the thorium and uranium were converted to the dicarbides in situ during fuel-compact fabrication. In addition to the different types of fuel starting material, three different particle sizes of each fuel material were used to permit comparison of radiation damage and fuel migration as a function of particle size. These sizes were <50μ, 110 to 250μ, and 250 to 500μ. (auth)

13245 (NAA-SR-Memo-1258) ELECTROPOLISHING OF SRE FUEL SLUGS. Amel Omo (North American Aviation, Inc., Downey, Calif.). Feb. 11, 1955. Decl. Nov. 6, 1958. 5p.

To remove the oxide layer on the Sodium Reactor Experiment fuel slugs, an electropolishing method was devised. Different electropolishing baths were tested, and all were found to give good results. A bath consisting of 46 vol.% H_2SO_4, 9 vol.% glycerin, and 45 vol.% H_2O was adopted; this bath gave a good polish with a current density of 0.3 amp/in.^{2} for ~1 min. The electropolishing method was compared with the pickling method using hot HNO_3 and was found to remove more of the oxide spots and to give a longer-lived polish. An electropolishing procedure for fuel slugs is outlined. (D.L.C.)

13246 (NMI-7235) POWER REACTOR PROGRAM. Progress Report to Savannah River Operations Office, United States Atomic Energy Commission for the Period December 1, 1960–December 31, 1960. S. Isserow, A. M. White, W. J. Richmond, W. L. Larson, P. R. Smoot, A. D. Donaldson, A. R. Gilman, and W. B. Tuffin (Nuclear Metals, Inc., Concord, Mass.). Feb. 8, 1961. Contract AT(30-1)-1565, Sponsor Agreement No. S-31. 27p.

Work was begun on a program to characterize cladding uniformity in relation to the history of the billet core. A demonstration set of unalloyed inner tubes was extruded. Heat treatment and physical metallurgy studies were undertaken for the U–0.3 wt.% Al–0.5 wt.% Si, U–0.3 wt.% Cr–0.3 wt.% Mo, and U–0.6 wt.% Al alloys. For studying diffusion of magnesium into Zircaloy, sandwich type couples were studied in the hope of eliminating some of the uncertainties inherent in the use of pre-wetted couples. A satisfactory Mg–0.4 wt.% Si casting was made for similar tests to study the diffusion processes. The apparatus for transient zone melting of tubular fuel elements was completed and the initial run was made. Additional billet designs have not eliminated the irregularities found near the outside edge of as-extruded stainless-steel–Zircaloy joints. (For preceding period see NMI-7234.) (auth)

13247 (NP-9871) THE PREPARATION OF HIGH PURITY BERYLLIUM AND THE STUDY OF ITS FLOW AND FRACTURE PROPERTIES. Final Report, June 30, 1959 to June 30, 1960. Marvin Herman, G. E. Spangler, and Edward Hein (Franklin Inst. Labs. for Research and Development Philadelphia). Contract NOas 59-6242-c. 26p. (F-A2323)

Several beryllium single crystals were prepared by the floating zone method of zone melting. These crystals, tested in tension, exhibited extensive basal plane glide prior to fracture. These observations represent a significant increase in ductility in comparison to previously reported

work. The increased ductility of the zone-melted crystals is discussed with respect to the purification attained and also with respect to the role of impurities in the presently proposed fracture mechanisms of beryllium. (auth)

13248 (NP-9884) DESIGN AND OPERATING PROCEDURES OF DYNAMIC OXIDATION TEST APPARATUS. C. E. Johnson (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Jan. 7, 1960. 16p. (DM-59-429)

A test apparatus was designed and constructed that enabled the measurement of temperature change due to dynamic oxidation (as distinguished from static) and the determination of auto ignition temperatures of niobium and niobium alloys. An air-mass flow rate of 8000 $lb/ft^2/hr$ at stabilized specimen temperatures in excess of 2600°F was achieved. (auth)

13249 (NP-9896) WORK AT THE PHYSICAL METALLURGY DIVISION OF THE MINES BRANCH ON NON-NUCLEAR USES OF URANIUM. Progress Report Number 1. (Canada. Dept. of Mines and Technical Surveys. Mines Branch). Feb. 23, 1961. 6p.

A program for the development of non-nuclear uses for uranium was initiated. The effect of uranium alloying additions on the corrosion resistance of steels in aqueous solutions, high-temperature oxidation of uranium-containing alloys, the effects of uranium additions to plain carbon-steels, the use of uranium as a deoxidizer for steel, the effects of small additions of Cr, Mo, Ti, and Ni on the microstructure of uranium-bearing steels, the use of uranium as an alloying element in chromium steels for high-temperature applications, and uranium additions to aluminum and copper and their alloys were investigated. (M.C.G.)

13250 (NYO-9197) DETERMINATION OF PARTICLE SIZE DISTRIBUTION BY X-RAY ABSORPTION. A. M. Gaudin and M. C. Fuerstenau (Massachusetts Inst. of Tech., Cambridge). [195?]. 6p.

Experiments were conducted to determine the effectiveness of x-ray absorption for determining particle-size distribution. Results indicate that the method should be useful for practical size distribution determinations to a lower limit of 100 to 1000 A. (J.R.D.)

13251 (SB-413) BERYLLIUM (1945–1960). OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). June 1960. 19p.

This bibliography includes about 225 references on beryllium. The references are arranged in sections for beryllium metal, alloys, carbides, other compounds, isotopes, and safe handling. The period covered is 1945 to 1960. (J.R.D.)

13252 (SB-414) COLUMBIUM AND TANTALUM. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). June 1960. 14p.

This bibliography includes about 240 references on niobium and tantalum metals, alloys, carbides, and other compounds. (J.R.D.)

13253 (SB-415) MOLYBDENUM AND TUNGSTEN. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). June 1960. 18p.

This bibliography includes about 380 references on molybdenum and tungsten metals, alloys, carbides, and other compounds. (J.R.D.)

13254 (SB-420) PLATINUM AND ALLIED METALS. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). July 1960. 8p.

This bibliography includes about 125 references on platinum group metals, alloys, and compounds. (J.R.D.)

13255 (TID-11558) MONTE CARLO RESEARCH SERIES: SINGLE VACANCY MIGRATION IN A TWO-DIMENSIONAL BINARY ALLOY. COMPUTER PROGRAM 0624. J. R. Beeler and J. L. McGurn (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Nov. 1960. Contracts AF 33(600)-38062 and AT(11-1)-171. 15p. (XDC-60-11-148)

GE-ANPD Monte Carlo program 0624 is written for the IBM 704 computer and computes the migration path of a single vacancy in a two-dimensional binary AB alloy. It is assumed that the lattice energy is the sum of all first neighbor interaction energies. Frequency factors associated with the twelve different possible first neighbor configurations for an atom adjacent to a vacancy can be arbitrarily assigned. The program prints an occupancy map for each vacancy jump and summarizes the jump directions, energy changes, and positions experienced by the vacancy during its history in tabular form. (auth)

13256 (WADD-TR-60-898) FLUIDS, LUBRICANTS, FUELS AND RELATED MATERIALS. E. Erwin Klaus, Merrell R. Fenske, and Elmer J. Tewksbury (Pennsylvania State Univ., University Park. Petroleum Refining Lab.). Jan. 1961. Contract AF33(616)-5460. 284p.

Work was carried out on a continuing program to characterize the capabilities of hydraulic fluids, lubricants, and functional fluids for aeronautic and astronautic applications under extreme environmental conditions. The effects of solvent type and solvent to oil ratio on the deep dewaxing process are shown. The yield and viscosity-temperature properties of the deep dewaxed oil are related to the type and degree of refining of the mineral oil fraction. The preparation of large volumes of super-refined mineral oil formulations for "mock-up" testing is reported. Extensive technical liaison on processing, properties, and application is discussed. Physical and chemical stability of base stocks, additives, and finished hydraulic fluid and lubricant formulations after 5 to 17 years in storage is described. A sample of hydraulic fluid taken from the "Lady Be Good" B-25 Bomber after 16 years in the North African desert is discussed. The design, construction, and preliminary testing of a versatile capillary pressure viscometer is reported. The use of this viscometer to measure the effect of gas solubility on viscosity and the analysis of flow profile in a capillary viscometer are discussed. The use of this pressure unit with a modified Lipkin pycnometer for the measure of bulk modulus is suggested. The thermal stability of esters is contrasted and compared as a function of chemical structure. Quantitative evaluations of the gas produced and the liquid phase are used to illustrate the effect of metal catalysts. The effects of fluid type, viscosity, vapor pressure, oxidation mechanism, oxidation inhibitor, and gaseous environment on evaporation are presented. The use of evaporation tests in studying the mechanism of oxidation is suggested. The relative lubricity properties of a series of high-temperature-bearing materials are reported. The relative effects of fluid volatility on lubricity are discussed. The similarities between high-temperature and the low-temperature lubricity properties of the residual fluids after high-temperature oxidation and thermal tests are pointed out. The wear properties of mineral oils and esters with and without lubricity additives are compared and contrasted with silicone and silicate fluids at 167 to 700°F. A simple, versatile, quantitative oxidation test is described for use with a variety of high-temperature oxidation tests. (auth)

13257 (WAPD-TM-264) EXAMINATION OF PWR CORE 1 BLANKET FUEL RODS FOR MICROSTRUCTURE,

HYDROGEN PICKUP AND BURST STRENGTH. B. Rubin (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Feb. 1961. Contract AT-11-1-GEN-14. 35p.

Three investigations were performed upon natural UO_2 fuel rods removed from the PWR blanket after 5800 efph of operation. Microexamination of the fuel revealed no radiation-induced changes, while the microstructures of the Zircaloy cladding and end caps showed modest amounts of uniformly distributed hydride. Hydrogen analysis of the Zircaloy indicated about 50 to 100 ppm. Hydraulic pressures of 13,200 to 14,900 psi were required for bursting of the rods. These results indicate that the rods are suitable for continued service. (auth)

13258 REFRACTORY MATERIALS IN THE NUCLEAR INDUSTRY. Jean Elston (Centre d'Etudes Nucleaires, Saclay, France). Ind. céram., No. 518, 2p.(Apr. 1960). (CEA-1614). (In French)

In reactors operating at high temperatures, refractory materials can be used for fuels, moderators or reflectors, thermal insulation, control rods and neutron screens, and neutron detectors. Except in the case of control rods and neutron screens and detectors, the refractory materials intended for nuclear use must be very pure. It is especially important to eliminate elements with a high capture cross section as completely as possible; thus a few parts per million of boron in a fuel or a moderator are considered harmful. Whatever their function in the reactor, refractory materials must be physically and chemically stable under the conditions of their use. (auth)

13259 DISLOCATION RELAXATION AT HIGH FREQUENCIES. P. G. Bordoni (Universita, Pisa, Italy and Istituto Nazionale di Ultracustica "O. M. Corbino," Rome). Nuovo cimento (10), 17: Suppl. No. 1, 43-91(1960). (In English)

The experimental evidence of a thermally activated relaxation effect due to dislocations is discussed together with proposed theoretical explanations. All basic parameters associated with the effect were considered and their experimental values compared with those given by theory. The influence of thermal and mechanical treatments, of impurity content, of high-energy irradiation, and of strain amplitude were examined from a quantitative standpoint. A model for dislocation motion was suggested from experimental results: the formation of kink pairs whose potential barriers and characteristic frequency depend only on the physical parameters of the single dislocations, not on their density or on the presence of foreign atoms. (M.C.G.)

13260 ELECTROREFINING PREPARATION OF HIGH PURITY THORIUM METALS. Sukeji Kachi, Tsuneo Satow, and Sakae Takeuchi (Research Inst. for Iron, Steel and Other Metals, Japan). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 56-65(Feb. 1959). (In English)

High-purity thorium metal was prepared by electrorefining, that is, by using $KThF_5$ or anhydrous $ThCl_4$ dissolved in a NaCl–KCl eutectic mixture as the electrolyte and crude thorium metal as the anode. Rare-earth and other impurities were thoroughly removed and the reactor-grade thorium could be obtained. The microstructures and some properties of refined thorium were also examined. (auth)

13261 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF PLUTONIUM. John Syme Nairn, Alan Marshall, and Roland Taylor. (to United Kingdom Atomic Energy Authority). British Patent 863,149. Mar. 15, 1960.

A method is given for the continuous production of plutonium from its halides by reduction. In this method plutonium halides are reacted with an alkali or alkaline earth metal in a fused salt medium at a temperature above the melting point of plutonium. The reaction may be carried out in a cathodically protected tantalum column, in which case plutonium halide and reducing metal in the form of fused salt solutions are fed at an intermediate point and near the bottom, respectively, and plutonium metal is drawn off at the bottom. The preferred plutonium halide is PuF_3 or $PuCl_3$ and the preferred reducing material is calcium, barium, strontium, or lithium; several possible fused salt mediums are suggested. (D.L.C.)

13262 METHOD OF OBTAINING UNIFORM COATINGS ON GRAPHITE. Ivor E. Campbell (to U. S. Atomic Energy Commission). U. S. Patent 2,978,358. Apr. 4, 1961.

A method is given for obtaining uniform carbide coatings on graphite bodies. According to the invention a metallic halide in vapor form is passed over the graphite body under such conditions of temperature and pressure that the halide reacts with the graphite to form a coating of the metal carbide on the surface of the graphite.

13263 DESCALING AND DECONTAMINATING METHOD FOR METALS. R. D. Baybarz (to U. S. Atomic Energy Commission). U. S. Patent 2,981,643. Apr. 25, 1961.

Oxide scale is removed from the surface of stainless steels and similar metals by contacting the metal under an inert atmosphere with a dilute sulfuric acid solution containing chromous sulfate. The removed oxide scale is either dissolved or disintegrated into a slurry by the solution. Preferred reagent concentrations are 0.3 to 0.5 M chromous sulfate and 0.4 to 0.6 M sulfuric acid. This process is particularly applicable to decontamination of aqueous homogeneous nuclear reactor systems.

Corrosion

13264 (AD-237775) THE ACCELERATED CORROSION OF METALS. Third Quarterly Report, Initial Exploratory Studies, March 16–June 15, 1960. David A. Jackson, Jr. (Virginia Inst. for Scientific Research, Richmond). June 27, 1960. Contract DA 18-108-405-CML-518. 28p.

A survey to find a unifying principle that may be helpful in determining the mechanism of accelerated metal corrosion is reported. Corrosion found in a number of metals, when in contact with metals and alloys that are liquid below 35°C, was observed. The types of deterioration noted include an accelerated oxidation rate of aluminum and magnesium in contact with mercury and its alloys and metal cracking such as that observed with aluminum, zinc, and tin in contact with gallium and its alloys. (J.R.D.)

13265 (BAW-1077) LIQUID METAL FUEL REACTOR EXPERIMENT. LIQUID METAL CONTROL ROD CORROSION TESTS. W. R. Foley (Babcock and Wilcox Co. Research Center, Alliance, Ohio). Oct. 1959. Contract AT (30-1)-1940. 15p.

Combinations of low-melting liquid metal alloys and various container materials were tested for 1,000 hr in tilting capsules. After visual and metallographic examinations, the following combinations were recommended for further testing: Ta (container), Bi–Sn–Cd (liquid metal); Ta, Bi–Cd; Mo–½Ti, Sn–Cd–Pb; Mo–½Ti, Bi–Sn–Cd; and Mo, Bi–Sn–Cd. (auth)

13266 (BAW-1210) CORROSION OF CADMIUM–STAINLESS STEEL COUPLES. Henry Shaw (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Sept. 1960. 12p.

Corrosion of cadmium which could initiate a criticality accident in the NS Savannah Refueling Barge is examined.

The corrosion of cadmium, in metallic couple with stainless steel, by the introduction of various electrolytes was studied for over 300 hr at room temperature and 75 to 85°C. Boric acid solution (2.55 g/l) was found to be the most corrosive medium for cadmium. Synthetic sea water had a significant effect on both members of the couple. The sodium hydroxide solution corroded the cadmium anode significantly only at the higher temperature. A mixture of sodium hydroxide, synthetic sea water, and borax corroded both members of the couple by half that of synthetic sea water alone. Borax (4g/l) and deionized water solutions were the least corrosive; the deionized water samples had almost insignificant weight changes. With increased exposure the electromotive force increased and the current decreased between the cadmium anode and stainless-steel cathode. The final voltages were about 20 μamp, a decrease of 30 μamp. On the basis of these experiments the use of boric acid for extended periods of time is not suitable in a stainless-steel–cadmium system. (auth)

13267 (KAPL-M-ECP-8) DISSOLUTION OF SIMULATED CIRCULATING CORROSION PRODUCTS IN MILDLY ALKALINE SOLUTIONS. Interim Report. E. C. Pitzer (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 21, 1961. Contract W-31-109-Eng-52. 14p.

Metallic oxides and hydroxides, simulating circulating corrosion products from stainless steel and Inconel loops, are soluble in mildly alkaline solutions of salts of ethylenediamine tetraacetic acid and suitable reducing agents such as sodium hydrosulfite. Other complexing agents, such as Calgon and sodium citrate, were found to be somewhat less effective than salts of ethylenediamine tetraacetic acid. Preliminary experiments revealed no appreciable attack upon autoclave films on Inconel or Zircaloy during removal of films of simulated corrosion products. (auth)

13268 (NAA-SR-Memo-2264) EFFECT OF CO_2 AND N_2 ATMOSPHERES IN REDUCING THE "CORROSION" RATE OF URANIUM IN SANTOWAX-R. H. C. Field (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 11, 1957. 2p.

Results are presented of an investigation on corrosion of uranium fuel plates by 350°F Santowax-R under an inert atmosphere of CO_2 or N_2. (J.R.D.)

13269 (NASA-TN-D-769) NASA-AEC LIQUID-METALS CORROSION MEETING, DECEMBER 7-8, 1960, WASHINGTON, D. C. (National Aeronautics and Space Administration, Washington, D. C.). Feb. 1961. 109p.

Eighteen papers on liquid–metal corrosion and the related areas of purification and chemical analysis are given. A summary of information is also included. All papers are covered by separate abstracts. (M.C.G.)

13270 (NASA-TN-D-769(p.3-13)) HIGH-TEMPERATURE CORROSION BY COOLANTS. David H. Gurinsky and Carl J. Klamut (Brookhaven National Lab., Upton, N. Y.).

Materials were investigated for boiling mercury and sodium content. For mercury containment effort was confined to an investigation of carbon steels clad with high-temperature-strength oxidation-resistant alloys using inhibitors such as titanium and zirconium and an investigation of refractory-metal alloys. The experimental program consists of capsule, natural-convection loop, forced-circulation loop, and solubility studies. Only refractory materials were considered for containment of boiling sodium at temperatures up to 2400°F. The experimental program consists of capsule tests, boiling natural-convection loops, boiling forced-circulation loops, and a small, alloy development program. (M.C.G.)

13271 (NASA-TN-D-769(p.15-24)) BOILING ALKALI METAL AND RELATED STUDIES. Eugene E. Hoffman (Oak Ridge National Lab., Tenn.).

Tests were conducted to determine the most accurate and reproducible analytical method for determining the oxygen content of potassium. Castings of high-purity K_2O were prepared for use in determining the solubility of K_2O in potassium. Commercial potassium was purified by hot gettering and subsequent cold trapping to produce a relatively oxygen-free material for use in compatibility and heat-transfer experiments. Potassium compatibility tests were run to compare the corrosion resistance of iron, nickel, cobalt, and niobium alloys. Weight-change data and metallographic examination of the test specimens indicated that Inconel has less corrosion resistance than stainless-steel or cobalt alloys. Two stainless-steel boiling-loop tests were conducted. (M.C.G.)

13272 (NASA-TN-D-769(p.25)) LIQUID-METALS CORROSION RESEARCH. Vincent J. Rutkauskas (Argonne National Lab., Ill.).

Refractory metals and alloys were exposed to flowing sodium at 650°C to select suitable materials for fuel jackets of future EBR-II fuel loadings. The effects of oxygen concentration and temperature on the corrosion resistance of refractory metals and stainless steels were studied. An experiment is planned to determine the effects of heat transfer and fluid flow in two-phase sodium systems. (M.C.G.)

13273 (NASA-TN-D-769(p.27-31)) LIQUID-METAL CORROSION RESEARCH. K. J. Kelly (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown).

The corrosion and mass-transfer behavior of commercial structural alloys and advanced refractory metals and alloys were evaluated in various liquid metals under nonboiling conditions. The effects of temperature, thermal gradient time, flow, and dissimilar metals were studied. The magnitude and temperature-dependence of the solubility of a number of elements in lithium was measured. Electrical resistivities of a 56Na–44K alloy and of lithium were measured in the range from room temperature to 1600°F. A method for the determination of total carbon in lithium was developed. Work was also carried out to find a better method for the determination of oxygen in lithium. (M.C.G.)

13274 (NASA-TN-D-769(p.33-44)) LIQUID-METAL CORROSION RESEARCH IN THE SNAP DEVELOPMENT PROGRAM. M. A. Perlow and J. R. Crosby (Atomics International. Div. of North American Aviation Inc., Canoga Park, Calif.).

The development of the three systems SNAP-2, SNAP-8, and SNAP-10 and liquid-metal corrosion conditions presented by each are discussed. The materials selected for core fabrication tests were stainless steels, Hastelloy, Haynes 25, Inconel X, molybdenum, and niobium. Thermal-convection loops were designed to contain the specimens in a NaK environment and to operate at temperatures from 1200 to 1500°F. The duration of testing and type and rate of attack are given for each specimen. An in-core compatibility study was made of beryllium specimens sandwiched between stainless steel 347 and Hastelloy N, both with and without interfaces of chromium and titanium. Results indicated that the chrome-plated beryllium interface withstood corrosion better than the others. (M.C.G.)

13275 (NASA-TN-D-769(p.45-7)) LIQUID-METAL INVESTIGATION. J. W. Semmel, Jr. (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati).

Programs involving the study of heat-transfer phenomena, the chemical analysis of alkali metals, the development of

materials for alkali metal containment, and the study of corrosion phenomena are described. Investigations are in progress to determine the metallurgical characteristics of Haynes-25 alloy that are pertinent to its use for a 300-kw heat-transfer loop. Methods developed for monitoring the oxygen in potassium in the heat-transfer loop are discussed. Results of niobium alloy investigations indicated that excellent as-welded room-temperature ductility can be obtained without preheating or postheating of alloys with a 100-hr rupture strength of 20,000 psi at 2000°F. Niobium alloys and a Mo–0.5 Zr alloy were heated in cold-trapped alkali metals for 300 hr at 1700°F to study corrosion. (M.C.G.)

13276 (NASA-TN-D-769(p.49-50)) ALKALI METAL CORROSION STUDIES. Robert J. Teitel (Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.).

At temperatures up to 1860°F, no corrosion was detected in a boiling sodium loop built of Haynes Stellite-25, 321 stainless steel, Inconel, and molybdenum. Specimens of Nb–1% Zr, molybdenum, niobium, and tantalum were subjected to boiler corrosion at temperatures to 1800°F in a boiling potassium loop. Capsule studies showed that Nb–Zr alloys had a greater corrosion resistance than Nb–Ni alloys. Intergranular corrosion was detected in nickel samples exposed to cesium at 1830°F. (M.C.G.)

13277 (NASA-TN-D-769(p.51-5)) EVALUATION OF MATERIALS IN LIQUID AND GASEOUS MERCURY. James J. Owens (Thompson Ramo Wooldridge Inc., [Cleveland]).

Corrosion in a mercury environment at temperatures up to 1150°F was studied in association with the development of the SNAP-2 system. Both reflux capsules and natural circulation loops were used as testing methods. The relative corrosion of carbon steels, stainless steels, high-nickel alloys, Ti, Pt, Mn, Mg, Al, Zr, Ta, W, TiC, and Mo alloys was measured in mercury at 900°F in 12-day tests. (M.C.G.)

13278 (NASA-TN-D-769(p.57-9)) LIQUID-METAL CORROSION RESEARCH. Malcolm F. Parkman (Aerojet-General Nucleonics, San Ramon, Calif.).

A program was planned to test niobium and stainless steel for compatibility with high-temperature liquid and gaseous rubidium. A stainless-steel capsule test was completed and negligible corrosion was observed. Design characteristics of the loops are given. As part of the SNAP-8 program, loops were constructed for component testing and heat-transfer studies. (M.C.G.)

13279 (NASA-TN-D-769(p.61-4)) LIQUID AND VAPOR ALKALI-METAL CORROSION AND RELATED RESEARCH. Eugene M. Simons (Battelle Memorial Inst., Columbus, Ohio).

The effects of liquid NaK on metals, alloys, cermets, and ceramics were studied in Inconel-X capsules. Corrosion by NaK in pumping loops was studied in a 500-hr test. Some voids to a maximum depth of 2 mils, surface roughening, and deposits were observed. The vapor pressure of rubidium at 650 to 850°K was determined. Corrosion tests were made on stainless steel, Inconel X, tungsten carbide–cobalt systems, beryllium, and silicon steel using rubidium liquid and vapor. The corrosion effects of liquid sodium on tantalum specimens were measured. Methods for continuous monitoring of sodium for oxygen impurities below 10 ppm are outlined. The frictional behavior of sodium-lubricated rubbing surfaces under nonhydrodynamic conditions was studied. Mo–0.5% Ti rods were tested for creep-rupture in potassium vapor. The properties of potassium liquid and vapor were studied. (M.C.G.)

13280 (NASA-TN-D-769(p.65-72)) LIQUID-METALS RESEARCH PROGRAM. Louis Rosenblum (National Aeronautics and Space Administration. Lewis Research Center, Cleveland).

Capsules were fabricated to test the resistance of various materials to corrosion by sodium or potassium at temperatures of 1600 to 2500°F. In an alkali-metal boiling and condensing corrosion loop test, several Inconel loops with potassium were run at 1600 to 1700°F for periods of time up to 500 hr. An apparatus was designed to measure the low vapor flow rates in these loops at temperatures from 1600 to 2500°F. The compatibility of elastomers and rubbers with alkali metals was studied. A test program was developed to determine the stability of various high-temperature thermocouples. (M.C.G.)

13281 (NASA-TN-D-769(p.73-4)) SODIUM LIQUID- AND VAPOR-PHASE CORROSION STUDIES AT HIGH TEMPERATURE USING RADIOCHEMICAL METHODS. Thomas A. Kovacina (Naval Research Lab., Washington, D. C.).

Various high-temperature properties of sodium in both the liquid and vapor phases to 2500°F were determined. The solubility of Nb–1% Zr alloy in liquid sodium and the transport rate of Nb–1% Zr alloy by condensing sodium vapors were also investigated. The possibility of utilizing tracer techniques to determine the gravity of the corrosion process caused by sodium is discussed. Two different methods for the separation of sodium from dissolved niobium and zirconium were investigated using tracer quantities of Nb^{95}–Zr^{95} mixtures. (M.C.G.)

13282 (NASA-TN-D-769(p.75-7)) ALKALI LIQUID METAL-TEST ACTIVITIES. Emil A. Kovacevich (Airesearch Mfg. Co. Div. of Garrett Corp., Phoenix, Ariz.).

Four categories of materials will be evaluated in a potassium environment in accordance with their applications in the Nuclear Space Power Generation System. The categories are turbine, alternator, container, and bearing materials. Mo–0.5% Ti, Nb–1.0% Zr, and Hastelloy-X are being tested in refluxing type capsules. A Hastelloy-X pump loop will be operated in order to obtain a compatibility index of Hastelloy-X with potassium. Erosion and corrosion evaluation tests will be conducted on journal-bearing configurations. (M.C.G.)

13283 (NASA-TN-D-769(p.79-81)) RESEARCH ON LIQUID METALS AND OTHER UNUSUAL MATERIALS. John R. May (Sundstrand Turbo. Div. of Sundstrand Corp., Denver).

Experimental programs related to liquid-metal technology and other unusual fluids are described. An engine using rubidium as a working fluid was built primarily of stainless steel. A second engine was fabricated from Inconel and was operated with both potassium and rubidium for a total system operating time of about 20 hr. It was found that rubidium was much more easily handled than potassium for applications of this nature. In the concept for a chemically fueled power system, which was first investigated, liquid sulfur was used as the Rankine cycle working fluid. Corrosion and thermodynamic studies indicated that sulfur is not very good for the working fluid. Therefore a change was made to aluminum bromide. The design parameters required for thermal energy storage for heat-source operation were investigated. (M.C.G.)

13284 (NASA-TN-D-769(p.83-6)) LIQUID-METAL BOILING SYSTEMS. J. W. Mausteller (MSA Research Corp., Callery, Penna.).

Potassium was manufactured by reacting KCl with sodium in a stainless steel column packed with Raschig rings. Columns were not replaced because of corrosion but be-

cause of thermal fatigue. Sodium was evaporated under reduced pressures using a NaK heating loop. Operation totaled 650 hr with sodium vapor velocities up to 3000 ft/sec through the nozzle. No corrosion or erosion was visually evident in the nozzle. Oxygen effects were considered in an oscillating-flow, isothermal sodium system at 925°F, holding oxygen to 0.003, 0.005, and 0.010 wt.%. Nitriding was investigated in a number of sodium systems at temperatures to 1300°F. Stainless steels were used to hold liquid lithium and lithium-salt mixtures at 2000°F for days and sodium-salt mixtures for months at 1600 to 1800°F with no drastic failures. (M.C.G.)

13285 (NASA-TN-D-769(p.87-9)) DYNAMIC LIQUID-METAL CORROSION STUDIES. W. D. Weatherford, Jr. (Southwest Research Inst., San Antonio).

A dynamic corrosion test apparatus was designed for studying the corrosion characteristics of selected liquid metals in turbulent flow and at temperatures approaching 2000°F and for an investigation of compatibility properties of fluids. The apparatus consists of a gravity-flow two-phase test loop mounted within a pressurized shell containing an inert-gas atmosphere. This inert gas is circulated along the exterior of the loop, countercurrent to the liquid-metal flow by means of an internal blower. (M.C.G.)

13286 (NASA-TN-D-769(p.91-2)) LIQUID-METAL RESEARCH. J. M. McKee (Nuclear Development Corp. of America, White Plains, N. Y.).

Heat-transfer coefficients to lithium from a tantalum wall at 2000 to 2400°F were measured. No significant corrosion was observed. Equilibrium solubility and solution rates for iron in lithium are being measured at 1100 to 1600°F using radiochemical techniques. A method for determining the oxygen content of sodium at levels below 10 ppm is described. Past work with liquid-metal systems is reviewed. (M.C.G.)

13287 (NASA-TN-D-769(p.93-4)) LIQUID-CESIUM RESEARCH PROGRAM. H. L. Stevens (Wright Air Development Div. Materials Lab., Wright-Patterson AFB, Ohio).

The effects of liquid cesium on materials of construction are being studied to obtain data necessary for the development of alloys and other techniques to prevent contamination of cesium and perforation of cesium containers. Capsule type corrosion tests of liquid cesium will be conducted under static conditions. Tests will be made of four refractory metals as containers for boiling-refluxing liquid cesium. (M.C.G.)

13288 (NP-9869) CATALYTIC EFFECTS IN THE INTERGRANULAR CORROSION OF HIGH-PURITY ALUMINUM IN HYDROCHLORIC ACID. Technical Report No. 4. O. P. Arora, G. R. Ramagopal, and M. Metzger (Illinois. Univ., Urbana). Dec. 28, 1960. Contract Nonr-1834(25). 33p.

Quantitative studies were made of grain boundary and general corrosion in aluminum ranging in copper content from 1 to 600 ppm. In 16% HCl, where the ratio of the intrinsic boundary-corrosion to general-corrosion rate of an aluminum was estimated as 8, the actual ratio of these rates was made to range up to 50 and down to nearly unity by varying catalytic action through the addition of increasing amounts of cupric ion to the acid. Boundary corrosion was more rapid with increasing copper content; at least as little as 21 ppm copper yielded a substantial effect and one greater than that of any other residual element. This behavior was explained as the result of an autocatalytic acceleration produced by the copper introduced by corrosion in a manner similar to that identified for general corrosion. The view obtained of corrosion in this system is that boundary and general corrosion are related phenomena and change in the same direction but to different extents with changes in copper content or acid composition so that the selectiveness of attack and the geometry of the intergranular crevice can vary widely. Highly selective attack occurred with conditions under which there was a preferential catalysis of the boundary reaction. (auth)

13289 (NRL-5572) ISOTHERMAL STUDY OF CONCENTRATION AND TRANSPORT OF RADIOACTIVE STAINLESS STEEL COMPONENTS IN LIQUID LITHIUM. W. N. Crofford, T. A. Kovacina, and R. R. Miller (Naval Research Lab., Washington, D. C.). Oct. 6, 1960. 11p.

Relative to the use of liquid alkali metals for heat-transfer media, a study was made of the reaction of lithium metal with stainless-steel-container material. Isothermal mass transfer and equilibrium concentrations of the components of 347 stainless steel in lithium were determined at 425, 625, and 825°C. The concentrations of components were determined by counting the disintegration of radioactive isotopes of the components. Comparisons were made between the lithium data obtained and available sodium data. (auth)

13290 (NYO-7990) MATERIALS FOR HANDLING DEIONIZED WATER. Technical Memorandum No. 51. Robert W. Struble (Princeton Univ., N. J. Project Matterhorn). Sept. 6, 1957. 16p.

A study was made to determine which materials should be used in the construction of a deionized water cooling system. Deionized water was found to be very similar to distilled water except for the organic content, which should have little effect on the conductivity of water except for the corrosion. The methods of corrosion are discussed. The investigation is a compilation of recommendations for materials for high-purity deionized water systems as recommended by manufacturers of deionizers and authoritative texts in the fields of corrosion and water systems. A galvanic series is given of some of the metals investigated. It was concluded that the most desirable metal for this use is aluminum, at a maximum temperature of 177°C, and wherever possible the system should be aluminum-clad. Glass or plastics are nonmetallic materials that are capable of handling deionized water without contaminating it. (B.O.G.)

13291 (WAPD-TM-261) EVALUATION OF CRUD DEPOSITS ON PWR BLANKET BUNDLES. R. D. Oldenkamp, C. F. Paulson, and Y. Solomon (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1961. Contract AT-11-1-GEN-14. 31p.

The investigations of the crud deposits found on PWR Core 1 Blanket Bundles are described and evaluated. The examination, descaling, and chemical and radiochemical analyses of the descaled material were performed at the Naval Reactors Facility, Expended Core Facility (ECF), Idaho Falls, Idaho. Physics calculations made at Bettis provided information on neutron flux levels and neutron spectra at the various locations and times in the core. The axial pattern of crud deposition on a seven-bundle assembly and on a single bundle was roughly parabolic, the minimum deposit being at the center, and the outlet end being higher than the inlet end. The maximum local deposit weight found was 78 mg/dm^2 as iron, or approximately 156 mg/dm^2 as crud, assuming the crud to be 50% iron. A small amount of crud removed by a short-time ultrasonic agitation in water

had a significantly different radiochemical composition from the bulk deposit. This radiochemical composition showed little variation with position. The bulk deposit composition indicated enrichment in iron and cobalt and depletion in nickel and chromium compared to the base metal of the major plant surfaces. It was concluded that the activity of the deposit on each fuel bundle resulted in part from irradiation in situ and in part from irradiation elsewhere in a higher neutron flux. Two parallel mechanisms for crud deposition were inferred from the data; one a hydraulic effect predominating at the inlet, the other an effect of total exposure to ionizing radiation which predominates at the outlet. An estimate of the maximum temperature increase at the crud-clad interface due to the heat transfer resistance of the crud is about 13°F. (auth)

13292 (NP-tr-565) MECHANISM OF METAL CORROSION IN NARROW SLITS AND CREVICES. I. L. Rosenfield and I. K. Marshakov. Translated from Zhur. Fiz. Khim., 2: 411-15(1959). 9p.

Corrosion of slits in magnesium and alloys ML-5 and MA-8 was investigated using water and NaCl solutions as corrosive media. The corrosion velocity in narrow slits (<0.50 mm) is higher than the bulk corrosion velocity, and pits form in the slits. The corrosion velocity reaches a maximum at a certain slit width which shifts to wider slits in solutions more concentrated in NaCl. With alloy MA-8, the slit corrosion velocity was found to be approximately constant, whereas the bulk corrosion velocity decreased with time. The corrosion and electrochemical behavior of these metals in aerated and oxygen-free 0.01 N NaCl solutions were studied. A mechanism for slit magnesium corrosion is proposed in which hydrogen bubble formation in the slit prevents the formation of a protective film. In dilute NaCl solutions, the bubbles result in intense mixing of the electrolyte in relatively narrow slits, whereas in concentrated solutions, the increased bubble formation prevents such mixing except in wider slits. The role of microelements and microelectrodes in the mechanism is discussed. (D.L.C.)

13293 CORROSION BY URANIUM HEXAFLUORIDE METHODS FOR STUDYING CORROSION. J. Dixmier, R. Hasson, S. Maravel, and L. M. Vincent (Center d'Etudes Nucléaires, Saclay, France). J. Nuclear Materials, 3: 41-59(Jan. 1961). (In French)

The chemical properties of uranium hexafluoride have prompted the development of new methods for studying the corrosion of metals by this gas. The corrosion process is characterized by the reactions between an anhydrous gaseous phase and a solid phase, which is comparable to the dry oxidation of metals. After a critical review of the principal methods used in this field, discontinuous gravimetry is chosen in which samples are weighed before and after attack by hexafluoride. Polished samples, run simultaneously, are examined micrographically. Specimen dimensions were chosen to achieve optimum conditions for microbalance weighing. Methods of preparation and surface condition of the specimens were carefully defined. Corrosion was effected by H-shaped tubes; the tubes, including joints, unions, seats, and butterfly valves, were made entirely of metal. The apparatus was sufficiently vacuumtight to permit routine degassing under a vacuum of 10^{-6} mm Hg at temperatures up to 400°C. After degassing, hexafluoride is introduced into the apparatus and triple distilled; the tube is kept warm. Incorporated at the end of one of the legs of each tube is a condensing attachment which, with the help of local cooling, permits a reservoir of solid hexafluoride to be maintained, with consequent constancy of gas pressure. When a tube is removed for examination, it is again pumped out to remove residual hexafluoride. It is opened in an inert atmosphere in a glove box and the specimens manipulated out of contact with air to avoid alteration of the corrosion products. Microweighing and micrographic examination are carried out. Progressive elimination of the deposits revealed etch pits, which often affected the shape of grain-boundary grooves or micropits. Their growth in depth was found to follow parabolic time-laws similar to those characteristic of dry oxidation curves. The precautions taken in preparing specimens and distilling the hexafluoride resulted in excellent reproducibility of the results. The sensitivity of the microbalance was sufficient to follow the formation of a fluoride monolayer. The ensemble of corrosion apparatus and methods of measurement was selected as being one of the most easily adaptable to the technology of uranium hexafluoride in that it gave great sensitivity and allowed serial experimentation on a vast scale. The ensemble is readily adapted to the study of numerous variables, such as time, temperature, and pressure. (auth)

13294 GRAPHITE–METAL COMPATIBILITY AT ELEVATED TEMPERATURES. J. C. Bokros (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Nuclear Materials, 3: 89-100(Jan. 1961). (GA-1101). (In English)

Numerous metals and alloys were screened for application as a cladding material on graphite to operate in helium at temperatures up to 1010°C. It was found that the heat-resistant nickel-base alloys, the stainless steels, and molybdenum all carburized rapidly above 816°C. In the case of niobium, a reactive metal, the results emphasize the importance of maintaining high-purity helium to prevent embrittlement. Of the alloys tested, nickel–copper alloys appeared to be the most promising for use as a high-temperature graphite cladding. Aging data indicated that Monel is more resistant to graphitization than nickel. (auth)

13295 HIGH TEMPERATURE OXIDATION OF ZIRCONIUM IN THE COLD HARDENED AND RECRYSTALLIZED STATES. R. F. Mocharnyuk (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian S.S.R.). Zhur. Fiz. Khim., 35: 112-17(Jan. 1961). (In Russian)

The kinetics of high-temperature oxidation of zirconium in the cold-hardened and recrystallized states revealed a considerable influence of the metal state on the oxidation process. The ratio of the emf's of the high-temperature galvanic cell metal (scale) oxygen for the ordinary and deformed states at 500 to 650°C was calculated. Equations describing logarithmic oxidation rate were derived for the temperature range of 200 to 400°C for both states of the metal, and it is shown that, as a rule, the oxidation process at these temperatures proceeds in two stages. The parabolic law is applicable at the oxidation rate of 500 to 650°C. On this basis, equations were obtained for the temperature dependence of the parabolic rate constants. The conductivity of oxide layers of the metal at various temperatures has been calculated, and equations have been derived for their temperature dependence. The results obtained are in agreement with the principles of the electrochemical theory of refractoriness. (tr-auth)

13296 ANODIC OXIDATION OF RHENIUM. V. A. Lavrenko (Kiev Inst. of Metal Ceramics and Special Alloys). Zhur. Fiz. Khim., 35: 198-200(Jan. 1961). (In Russian)

The anodic behavior of rhenium in 30% H_2SO_4 in recrystallized and cold-worked states was studied by polarization and charging curve methods. The activation energy of the oxidation reaction depends upon the state of the system at

the metal-oxide boundary. Cold-working increases the number of active reaction centers, facilitating the oxidation process and dissolution of the higher rhenium oxides. (tr-auth)

13297 METHOD OF IMPROVING CORROSION RESISTANCE OF ZIRCONIUM. Donald W. Shannon (to U. S. Atomic Energy Commission). U. S. Patent 2,977,204. Mar. 28, 1961.

An improved intermediate rinse for zirconium counteracts an anomalous deposit that often results in crevices and out-of-the-way places when ordinary water is used to rinse away a strong fluoride etching solution designed to promote passivation of the metal. The intermediate rinse, which is used after the etching solution and before the water, is characterized by a complexing agent for fluoride ions such as aluminum or zirconium nitrates or chlorides.

Fabrication

13298 (AD-229373) PRODUCTION OF EXTRUSION BILLET OF HIGH TEMPERATURE AIRCRAFT ALLOYS BY POWDER METALLURGY. First Interim Engineering Report, Phase I–June 15, 1959–October 31, 1959. Gail F. Davies and Robert D. Johnson (Clevite Corp. Mechanical Research Div., Cleveland). Contract AF 33(600)-39327. 41p.

A commentary on the various available methods for the production of extrusion billets from metal powder and their relative capabilities are given. Included is a discussion of the current sources of powder, the type of powder available, and a brief description of the methods employed in their production. A review of alloys suitable for study in Phase II and Phase III of the program is presented, based upon the preliminary survey of alloys currently being applied in the programs of the Air Force which are adaptable to the processes selected for this project. A description is included of some preliminary work on compaction and extrusion of Udimet powders. Tensile properties comparable to those obtained with wrought material are reported for bar stock extruded from a powder billet of Udimet 500. (auth)

13299 (AMC-TR-7-775(II)) COLUMBIUM AND COLUMBIUM ALLOY EXTRUSION PROGRAM. PHASE II: BILLET PROCESS DEVELOPMENT. Interim Report II. A. W. Dana, Jr. (Du Pont de Nemours (E. I.) & Co. Pigments Dept., Wilmington, Del.). Feb. 6, 1961. Contract AF33(600)40700. 96p.

An extrusion billet production process for niobium alloy D-31 (Nb–10Ti–10Mo) is described. This process involves the casting of an 8-in.-diameter ingot by double consumable arc melting and extrusion to a 4-in.-diameter round. Quality control tests on ingot and billet are detailed along with metallurgical analyses required to establish process limits. (auth)

13300 (APAE-72) WELDED TRANSITION JOINT BETWEEN 2-1/4% Cr 1% Mo STEEL AND TYPE 316 STAINLESS STEEL. SODIUM COMPONENTS DESIGN PROJECT RESEARCH AND DEVELOPMENT PROGRAM–FINAL REPORT. (Alco Products, Inc., Schenectady, N. Y.). Aug. 15, 1960. 66p.

A steam generator, wherein the boiler, steam drum, and superheater are integrated into one single unit, requires the welding of a transition joint between the 2¼% Cr–1% Mo steel of the steam drum and the type 316 stainless steel of the superheater. A practicable procedure was developed for the welding of this transition joint and the properties of the weld were evaluated by mechanical testing and metallurgical evaluation. After evaluating the technical aspects of the project and their relation to the fabrication of the generator, it was considered desirable to overlay the welding edge of the 2¼% Cr–1% Mo steel with a suitable austenitic weld metal which would subsequently be welded to the type 316 stainless steel of the superheater. Austenitic stainless steel and high-nickel alloy weld metals were evaluated for the overlay; whereas only austenitic stainless steel weld metals were evaluated for the final weld joining the components. It was concluded that type 309 stainless steel weld metal deposited automatically by the submerged-arc process is completely satisfactory for cladding the 2¼% Cr–1% Mo base metal and for making the final transition weld joining the steam drum and superheater sections of the generator. Supplementary mechanical tests, metallographic examinations, and hardness surveys further attested to the adequacy of the quality of the transition joint resulting from the procedures developed by this program. A detailed fabrication and thermal treatment specification is included for the welding of a transition joint between 2¼%–1% Mo steel and type 316 stainless steel. (auth)

13301 (ASC-TR-7-882(I)) HIGH ENERGY RATE EXTRUSION. Interim Technical Progress Report No. 1, September 23, 1960 to January 1961. G. A. Reimann (Westinghouse Electric Corp. Materials Mfg. Dept., Blairsville, Penna.). Feb. 1961. Contract AF33(600)-41948. 35p.

The application of the pneumatically-actuated Dynapak machine as an extrusion tool is discussed, outlining design, operation, capabilities, and limitations. Industry's current capabilities, problems, and practices are described. The functional relationships of Dynapak components during the firing cycle are described. A mathematical analysis of Dynapak motion was developed. Certain aspects of basic extrusion theory are discussed and the application of this theory to high-energy-rate extrusion is described, with particular emphasis on the energy requirements necessary to extrude a given volume at various reduction ratios and on the conditions that produce inertial separation. Tooling problems are outlined, with recommendations as to steel selection, desired properties, and design. Information relating industry's experience with Dynapak is presented with a discussion of properties and dimensions of the extruded materials and the operating parameters used to obtain them. (M.C.G.)

13302 (BMI-X-160) COATING AND PREPARATION OF URANIUM AND THORIUM CARBIDE POWDERS. J. H. Oxley, R. B. Landrigan, A. C. Secrest, C. F. Powell, and J. M. Blocher, Jr. (Battelle Memorial Inst., Columbus, Ohio). Aug. 2, 1960. 47p.

Rate data were obtained for the deposition of carbon films from methane and acetylene in fluidized beds of alumina, uranium dioxide, uranium monocarbide, uranium dicarbide, and a solid solution of uranium–thorium dicarbide powders. The carbon films were shown to provide excellent protection for the powdered fertile material against attack by hot concentrated nitric acid solutions. Exploratory experiments were made to investigate the possibility of preparing niobium carbide coatings. Approximate conditions for the codeposition of uranium and carbon were determined for a fluidized-bed vapor-deposition process. The reaction of which the data are characteristic is uncertain, since positive identification of the product as the carbide was not established. Iodine, uranium tetraiodide, methane, hydrogen, zinc, and helium gases were used as the feed and fluidizing medium for a presumably inert bed of alumina particles at 1100 to 1300°C. One exploratory experiment was made to investigate the deposition of thorium carbide from a similar feed mixture. (auth)

13303 (BMI-X-166) ZIRCALOY–STAINLESS STEEL BONDING PROGRAM. First Quarterly Report, December 1960 to March 1961. S. W. Porembka (Battelle Memorial Inst., Columbus, Ohio). Mar. 7, 1961. 31p.

An investigation was made of the joining of Type 410 stainless steel to Zircaloy-2 by friction-bonding techniques. Preliminary design was completed on a full-scale friction-bonding apparatus. An attempt was made to determine a joint design that would minimize Zircaloy-2 upsetting during bonding. Because of their relatively low strength at moderate temperatures, the Zircaloy members were extruded into the bore of the stainless-steel tubing. By inserting a mandrel into the bore of the joining members, this extrusion effect was virtually eliminated. In all specimens, regardless of the extent of bonding, shearing of the Zircaloy was noted. The effects of surface preparations and rolling parameters were studied in an effort to join the Zircaloy-2 and stainless steel by cold-rolling techniques. Results showed that machined surfaces yield a greater degree of joining than those subjected to either belt abrading or commercial Zircaloy-2 etchants. The rolled taper specimens resulted in extreme cracking of both materials at the specimen ends. A study is being conducted to determine the feasibility of employing explosive techniques for the joining of Zircaloy-2 to stainless steel. (M.C.G.)

13304 (CEA-1669) CONTRIBUTION A L'ETUDE DE PROCEDES D'OBTENTION ET DES PROPRIETES DES SOLIDES FINEMENT DIVISES ELABORES DANS UN REACTEUR A FLAMME. (Contribution to the Study of the Production and Properties of Finely Divided Solids, Prepared in a Flame Reactor). Jean-Pierre Cuer (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). Apr. 2, 1960. 70p.

Thesis submitted to the Univ. of Paris.

Sufficiently fine particles cannot be obtained by the grinding of crystals. It is therefore logical to adopt a method whereby the solid is formed from a compound in the vapor phase. Notable amongst such compounds are certain organic derivatives of metals and the metallic halogenides which are volatile at moderate temperatures. Formation of the solid from its gaseous derivative should be possible by hydrolysis or oxidation without the dispersion of the reaction medium being modified. The simplest method seems to be to obtain the reaction in an oxyhydrogen blow-pipe. When the gases in the blow-pipe contain a volatile metallic compound, precipitation of finely divided solid in the form of oxide is produced in the flame at high temperature. Aluminum, titanium, iron, and zirconium oxides and silica, the particles of which are spherical and homogeneous in diameter, were prepared in this way. The specific surfaces calculated from the diameters on electron microscope photographs are in agreement with those measured by adsorption of nitrogen at −195°C. The oxides thus prepared are therefore not intensely porous. The properties and size of the oxide particles are studied as a function of various operational parameters, such as flame temperature and concentration of volatile metal derivative in the reactive gases. When the blow-pipe is supplied with oxide particles of small diameter, a very marked increase in size is observed. The properties of these preparations are also examined. (auth)

13305 (CEA-1680) SOUDAGE DE BOUCHONS ET GAINES EN ALLIAGES DE MAGNESIUM. (The Welding of Magnesium Alloy Plugs and Canning). P. Thome and C. Bridoux (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay). Aug. 31, 1960. 43p.

The end or lateral welding of Mg–Zr plugs presents no special difficulties in the manufacture of fuel-element slugs. The welding parameters were determined from penetrations and from the mechanical resistance. The unavoidable notching effect has received particular attention. It is possible to substitute a Mg–Zr plug without any modification of the optimum welding conditions and the various qualities of the weld. (auth)

13306 (DMIC-Memo-86) SUPERALLOY FORGINGS. H. J. Henning and F. W. Boulger (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Feb. 10, 1961. 43p. (PB-161236)

A review is given to provide useful data on sizes, shapes, and mechanical properties of superalloy forgings for cobalt-, iron-, and nickel-base alloys which have useful service temperatures at 1200 to 1800°F. (B.O.G.)

13307 (DP-440) MOUNTING THERMOCOUPLES ON SPERT TEST ASSEMBLIES. H. S. Sanders (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). December 1959. Declassified Sept. 1, 1960. 7p. Contract AT(07-2)-1.

A method of fastening thermocouples to 0.030-in.-thick aluminum cladding on test fuel elements was developed. The installation does not lead to hot spots by the addition of extra metal or the distortion of the cooling water channels. Fuel-element temperatures were faithfully followed in SPERT tests up to the melting point. The method was useful for fastening thermocouples to aluminum sections. (auth)

13308 (HW-63151) FABRICATION OF ALUMINUM–PLUTONIUM ALLOY FUEL ELEMENTS BY COEXTRUSION. W. J. Bailey, C. H. Bloomster, Y. B. Katayama, and W. T. Ross (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1, 1959. Contract AT(45-1)-1350. 35p.

The development of the fabrication process and preparation of 144 coextruded fuel elements for the Trans-Plutonium Program are described. The fuel elements were in the form of coextruded rods, 0.94 in. in diameter and 60 in. in length. The cladding was aluminum (X-8001 alloy) and was 0.040 to 0.120 in. thick. The fuel cores were aluminum–7.35 wt.% plutonium alloy. The fuel elements were coextruded in an extrusion press which was mounted in a plutonium-contaminated glove box. The extruded elements were easily decontaminated. The cast fuel cores for the coextrusion billets were machined only on one end. The fuel elements are currently under irradiation. (auth)

13309 (NOR-61-6) PROGRAM FOR THE DEVELOPMENT OF EXTRUDED BERYLLIUM SHAPES. Interim Engineering Report No. 10, September 1, 1960 through November 30, 1960. (Northrop Aircraft, Inc., Hawthorne, Calif.). Contract AF 33(600)-36931. 28p.

A summary of activities in Phase I of the beryllium extrusion program is presented. The feasibility of unclad beryllium extrusions was demonstrated; however, additional work was considered necessary to perfect extrusion methods to the degree where 20 ft of defect-free section could be fabricated. Recent efforts directed toward the development of a 20-ft extrusions resulted in a 26-ft-long extrusion with few defects. This represents the longest extrusion to date. It had not been possible to establish a reasonable degree of consistency, and this lack of consistency was attributed to the rather low top speed of the Nuclear Metals press. Because of this, arrangements were made to have an exploratory extruding effort performed through Nuclear Metals at another facility with a newer

and more adequate press. The results of high ram speed tests were quite favorable. For the first time in the program reproducible results were obtained with set conditions. The consistent and very rapid speed of the ram minimized the variations of temperature which would otherwise have occurred. Three consecutive 11-ft-long beryllium extrusions were made without a tearing defect. The next item of effort will be to further refine the process and to establish means of increasing the quality product to a full desired 20 ft. (For preceding period see NOR-60-272.) (auth)

13310 (NP-9911) DEVELOPMENT OF TECHNIQUES FOR PRODUCING BERYLLIUM STRUCTURAL SHAPES. Second Interim Technical Report [for] Period October 29, 1960–January 28, 1961. K. C. Taber and E. E. Weismantel (Beryllium Corp., Reading, Penna.). Contract AF33(600)-41959. 44p.

The technical effort expended in the first three months after starting Phase II is described. The initial effort included the formulation of a detailed technical program with the prime objective of producing beryllium sheet and strip having properties of 55,000 and 75,000 psi in yield strength and ultimate strength, respectively. Various starting materials and rolling and extrusion parameters were evaluated for ultimate application in subsequent forming of structural angles, channels, and zees through bending processes. Studies of the other structural shapes, including tees, rounds, and squares, indicated that gross deformation processes are necessary to obtain the required properties. Square extrusions and hot-pressed stock were prepared for deformation experiments. (auth)

13311 (SB-441) EXPLOSIVE METAL FORMING. OTS SELECTIVE BIBLIOGRAPHY. (Office of Technical Services, Washington, D. C.). Dec. 1960. 3p.

A bibliography is presented of reports which are listed in U. S. Government Research Reports and Technical Translations. 32 references. (J.R.D.)

13312 (TID-7570(Del.)) MINUTES OF THE EIGHTH ANNUAL ATOMIC ENERGY COMMISSION WELDING CONFERENCE HELD IN RICHLAND, WASHINGTON, OCTOBER 13-15, 1958. Division of Reactor Development, AEC) Decl. with Deletions July 19, 1960. 407p.

The minutes of the Eighth Annual Atomic Energy Commission Welding Conference are presented. Topics discussed include the welding of type 347 stainless steel, the effect of aging heat-treatments on the corrosion resistance of some austenitic stainless steels, Inconel weld deposits for nuclear applications, fuel-element welding practice at Hanford, the determination of aluminum weld strength characteristics, relation between welding power sources and aluminum weld quality in aluminum–silicon-bonded fuel elements, the sealing of small high-pressure sheet-metal containers, tungsten–arc cutting of stainless steels, ultrasonic weld inspection, and Hanford experience in the nondestructive testing of nuclear process vessels and process piping. (M.C.G.)

13313 (AEC-tr-4488) CALCULATION OF FORCES AND POWER REQUIRED FOR THE EHRHARDT TUBE MANUFACTURING PROCESS. A. Geleji. Translated from Acta Tech. Acad. Sci. Hung., 7: No. 3-4, 477-505 (1953). 22p.

The Ehrhardt tube manufacturing process is discussed. The forces and power needed for fill-up piercing, drawing tube over mandrel, and for a tube push bench were calculated. (M.C.G.)

13314 (AEC-tr-4489) OPERATING TESTS ON POWER REQUIRED FOR THE EHRHARDT TUBE PUSHING PROCESS. A. Geleji, E. Kiss, and G. Devenyi. Translated from Acta Tech. Acad. Sci. Hung., 22: No. 3-4, 395-412(1958). 15p.

Investigations were made of measurements of the following data for the Ehrhardt tube process: piercing force, piercing speed, pushing force, pushing speed, power input to the push bench drive motor, and the pattern of the piece's temperature. Measurements were made on the production of 70-, 85-, and 110-mm diameter steel tubes. A comparison of measured and calculated values is included. (M.C.G.)

13315 THE METALWORKING BEHIND OUR FIRST NUCLEAR POWER STATION. James A. Weller, ed. (Canadian General Electric Co. Ltd., Toronto). Can. Mach. and Metalwork., 71: 114-17(Aug. 1960).

Metalworking problems presented and solved in the building of Canada's first nuclear power station are outlined. The problems ranged from powder metallurgy to welding and from gun drilling to component inspection. New welding methods, advanced machining, stringent inspection, new materials, and tooling set-ups are discussed. (M.C.G.)

13316 THE METALWORKING BEHIND OUR FIRST NUCLEAR POWER STATION. PART 2. NOTHING BUT WELDING PERFECTION PERMITTED. James A. Weller, ed. (Canadian General Electric Co. Ltd., Toronto). Can. Mach. and Metalwork., 71: 84-8; 149(Sept. 1960).

The welding performed in the manufacture of the NPD-2 nuclear power station is described. For welding operations on both the calandria and moderator dump tank, the inert gas-shielded metal-arc process was specified and, wherever possible, fully automatic welding was employed. Every type of weld point was completely prototyped and tested by x ray, fluorescent penetrants, and macro- and micro-tests. In order to seal the fuel elements to prevent corrosion and to contain the fission product gases, a process was developed for fusion welding of the Zircaloy-2 sheath and the solid Zircaloy-2 end plug. (M.C.G.)

13317 THE METALWORKING BEHIND OUR FIRST NUCLEAR POWER STATION. PART 3. "ON-POWER" FUELING TESTS MACHINISTS' SKILL. James A. Weller, ed. (Canadian General Electric Co. Ltd., Toronto). Can. Mach. and Metalwork., 71: 112-16(Oct. 1960).

Research and development work in the field of "on-power" refueling is reviewed. The system of refueling adopted in the NPD-2 power station employs two remotely controlled fueling machines. The reactor core vessel was designed so that tubes in which the reaction takes place are "accessible" from both ends. Thus one machine can push a new bundle of fuel into one end of a tube while the machine at the other end collects the spent fuel bundle thereby displaced. The development of the machined assemblies for this system is described. (M.C.G.)

13318 THE METALWORKING BEHIND OUR FIRST NUCLEAR POWER STATION. PART 4. EVEN THE FUEL IS MACHINED TO ± 0.0005 IN. James A. Weller, ed. (Canadian General Electric Co. Ltd., Toronto). Can. Mach. and Metalwork., 71: 76-81(Nov. 1960).

Fuel bundle manufacture for the NPD-2 reactor brought about research into powder metallurgy, machining compacted uranium oxide, ultrasonic tube inspection, zirconium fabrication, and surface treatment. The uranium oxide pellets were machined so that the diameter had a tolerance of ± 0.0005 in. Methods were developed for welding the Zircaloy-2 sheaths to the end plugs. Testing procedures for these welds are described. (M.C.G.)

13319 HOW TO WELD COLUMBIUM ALLOYS. USE OF NEW ENGINEERING MATERIAL HINGES ON PROPER TECHNIQUES. Iron Age, 186, No. 24, 110-12(Dec. 15, 1960).

Various welding methods for niobium are discussed. The advantages and disadvantages of resistance, ultrasonic, and diffusion welding are evaluated. Tables are given comparing electron-beam and tungsten-inert-gas welding, showing how argon affects weldability, and giving results of tests of fusion welding and spot welding on niobium alloys FS-82 and FS-48. (T.R.H.)

13320 ELECTRON BEAM MELTING: WHAT IT DOES FOR METALS. Donald Pecker. Materials in Design Eng., 53: No. 3, 101-6(Mar. 1961).

The technique of melting metals by electron-beam bombardment is briefly described, and its advantages and disadvantages are outlined. Its main advantages are that contamination is prevented, and many impurities are removed by volatilization into vacuum. Data are given for the effects of electron-beam melting as compared with arc melting on the interstitial contents of cobalt and hafnium and on the mechanical properties of Be, Hf, V, W, Nb alloys, Ta–W alloys, and Co. (D.L.C.)

13321 STUDIES ON CLADDING. Eihachirô Tanaka and Tadatsugu Yoshiki (Research Inst. for Iron, Steel and Other Metals, Japan). Sci. Repts. Research Inst., Tohoku Univ., Ser. A, 11: 317-31(Aug. 1959). (In English)

Two kinds of light metal having different flow resistance were bonded by hot rolling, hot extrusion, and cold rolling. In the case of cladding by cold rolling, the combination of titanium and aluminum alloys (24S) was bonded for the investigation of some defects such as ripple and crack. Satisfactory conditions were obtained under which bonding without defects could be made. (auth)

13322 IMPROVEMENTS IN OR RELATING TO METHODS OF MANUFACTURING THIN DIAPHRAGMS, AND DIAPHRAGMS MADE ACCORDING TO THESE METHODS. (to Commissariat a l'Energie Atomique). British Patent 856,230. Dec. 14, 1960.

A method is given for manufacturing thin diaphragms reinforced on one side with metal grids or projections. The projections are formed on the diaphragm material (usually aluminum or an aluminum alloy) by stamping on one side with a tool and then subjecting the assembly to anodic oxidation, stopping when the oxidized region reaches the base of the projections. This oxidation treatment renders the diaphragm microporous. This method may also be used to manufacture targets for use in storage tubes by metalizing the smooth side, i.e., the side away from the projections. (D.L.C.)

13323 IMPROVEMENTS IN OR RELATING TO THE TREATMENT OF GRAPHITE. Christopher Tyzack and Alan Featonby Adamson. (to United Kingdom Atomic Energy Authority). British Patent 861,376. Feb. 22, 1961.

A method is given for increasing the oxidation resistance of a shaped graphite body that is to be used in CO_2-cooled reactors. This method consists of impregnating the body with a compound of phosphorus, sulfur, or silicon and heating to above the decomposition temperature of the compound, preferably to 1000°C in an argon atmosphere. (D.L.C.)

13324 IMPROVEMENTS IN OR RELATING TO SEALING MEANS. Kenneth Hartley, George MaClennan, and Clifford MacDonald. (to United Kingdom Atomic Energy Authority. British Patent 861,485. Feb. 22, 1961.

A sealing means is designed for use in combination with a vertical access duct in a chemical process vessel that contains radioactive material. The means is a metal plug 5.125-in. long and 1.75 in. in diameter with a spherical end that fits into the conical lead-in surface of the duct and a tongue at the other end that can be grasped by a mechanical remote handling manipulator. When the plug is made out of stainless steel, it weighs ~2 lb and thus provides an effective seal against an internal pressure of 1- to 2-ft water gage, and no sealing gasket is required. A device for washing down powder adhering to the duct after loading is also described. (D.L.C.)

13325 PREPARATION OF COMPACTS MADE FROM URANIUM AND BERYLLIUM BY SINTERING. R. P. Angier (to U. S. Atomic Energy Commission). U. S. Patent 2,979,399. Apr. 11, 1961.

A powder metallurgical method for making high-density compacts of uranium and beryllium is reported. Powdered UBe_9 and powdered Be are blended, compacted, and then sintered by rapidly heating to a temperature of approximately 1220 to 1280°C in an inert atmosphere.

13326 FUEL ELEMENT AND METHOD OF PREPARATION. W. E. Kingston (to U. S. Atomic Energy Commission). U. S. Patent 2,981,672. Apr. 25, 1961.

A nuclear fuel element in the form of a wire is reported. A bar of uranium is enclosed in a thin layer of aluminum and the composite is sheathed in beryllium, zirconium, or stainless steel. The sheathed article is then drawn to wire form, heated to alloy the aluminum with both uranium and sheath, and finally cold worked.

Properties and Structure

13327 (59-RL-2290M) TEMPER BRITTLENESS—A REVIEW OF RECENT WORK. J. R. Low, Jr. (General Electric Co. Research Lab., Schenectady, N. Y.). Oct. 1959. 22p.

The major points covered by Woodfine are summarized, and work since 1952 is reviewed. The principal new findings are as follows: Low-alloy steels are free of temper brittleness if made sufficiently pure; tungsten as well as molybdenum will inhibit temper brittleness but only when added in the correct amount; and despite widespread use of the electron microscope for the metallographic and fractrographic examination of embrittled steels, no evidence exists for precipitation or the formation of second-phase grain boundary films as the cause of temper brittleness. The mechanism of temper brittleness is still not known. 63 references. (auth)

13328 (AD-239291) DEVELOPMENT OF A NICKEL-BASE MATERIAL DISPERSION-HARDENED BY ALUMINA FOR 1600°F TO 2000°F SERVICE. Progress Report No. 6, [for period] November 7, 1959–January 6, 1960. D. H. Feisel (Westinghouse Electric Corp. Research Labs., Pittsburgh). April 14, 1960. Contract NOas-59-6051-C. 13p.

Compression tests of the as-extruded alloys at room temperature and a number of elevated temperatures up to 1800°F were completed. A significant finding is that the compressive yield properties for all alloys and temperatures are superior to comparable tensile yield properties. Additional stress-rupture data are included. (For preceding period see NP-8446.) (auth)

13329 (AE-46) THE MAGNETISATION OF MnB AND ITS VARIATION WITH TEMPERATURE. N. Lundquist and H. P. Myers (Aktiebolaget Atomenergi, Stockholm). Nov. 1960. 28p.

It has been shown that MnB is the only ferromagnetic phase occurring in the Mn–B system. The magnetization per unit mass at 0°K and in infinite field strength was found to be 163 corresponding to a Bohr magneton value 1.92 per

manganese atom. The Curie temperature in zero field is 300°C. The significance of this magnetic data is discussed. (auth)

13330 (AFOSR-TR-60-174) FRACTURE ARREST BY RIVETED STIFFENERS. Final Report. James P. Romualdi and Paul H. Sanders (Carnegie Inst. of Tech., Pittsburgh). Oct. 1960. Contract AF49(638)-237. 108p.

The occurrence of rapid, apparently brittle fracture became more prevalent with the advent of higher working stresses and lower operating temperatures. The problem is particularly severe in the aircraft, shipbuilding and pressure vessel industries. The mechanics of arresting a running crack before complete failure of the structure is one aspect of the problem. This facet of the study of fracture is of considerable interest and has many immediate applications. When structures are designed using crack-arresting criteria they are referred to as "fail-safe." The effectiveness of riveted stiffeners as crack arrestors is examined. The theoretical analysis results, based on an energy release concept, are compared with experimental results for several cases. Design recommendations based on experimental findings are included. (auth)

13331 (APEX-583) PHASE DIAGRAM STUDIES FINAL REPORT, JANUARY 9–DECEMBER 31, 1958. R. F. Domagala (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Mar. 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 56p.

Phase relationships in the binary systems Y–Fe, Y–Ni, and Y–Cu were studied. Yttrium metal and high-purity alloying ingredients were employed. Conventional nonconsumable electrode arc-melting techniques were employed for preparing the ingots; compositions were chosen at appropriate intervals from 0 to 100% of the alloying addition. As-cast and annealed samples were studied metallographically; melting-point and x-ray studies also aided in defining phase relationships. The melting point of yttrium metal was sharply reduced with small additions of either iron, nickel, or copper. Less than 1 wt.% iron, nickel, or copper was soluble in solid yttrium. Conversely, less than 1 wt.% yttrium was soluble in iron-, nickel-, or copper-rich solid solution. Each of the diagrams was characterized by the presence of several intermetallic compounds. In the Y–Fe system, YFe_2, YFe_3, YFe_4, and YFe_9 phases exist. In the Y–Ni diagram intermediate phases of the following stoichiometry were positioned: Y_3Ni, Y_3Ni_2, YNi, YNi_2, YNi_3 YNi_4, YNi_5, and YNi_9. Finally, in the Y–Cu system, YCu, YCu_2, YCu_4, and YCu_6 phases were found. Only one intermetallic compound had a melting point higher than that of yttrium. Although most of these phases had maximum melting points, a number of them was formed by peritectic reactions. (auth)

13332 (ARF-2194-1) A STUDY OF THE Ti–ZrO_2 SYSTEM. Progress Report No. 1, March 15 to June 14, 1960. R. F. Domagala (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 15, 1960. Contract [AF]33(616)-7074. 9p. (AD-238728)

Phase relations along the vertical section from titanium to ZrO_2 are being investigated in the Ti–Zr–O system. Alloys are prepared by arc-melting calculated amounts of high-purity titanium and zirconium dioxide. Twenty-five compositions were melted. As-cast structures were viewed metallographically. Specimens up to 60 wt.% ZrO_2 were homogenized for 1 hr at 1600°C. Samples are currently being prepared for isothermal anneals and a cursory melting point vs. composition study. (auth)

13333 (BMI-1502) THERMAL DIFFUSION IN A SOLID SOLUTION OF HYDROGEN IN BETA ZIRCONIUM. John W. Droege (Battelle Memorial Inst., Columbus, Ohio). Feb. 24, 1961. Contract W-7405-eng-92. 40p.

The thermal diffusion of hydrogen in β zirconium was investigated at two compositions ($ZrH_{0.44}$ and $ZrH_{0.86}$) and at temperatures from 630 to 860°C. A diffusion cell containing a sample of zirconium hydride was subjected to a thermal gradient. The hydrogen pressure was determined at the hot and cold ends of the specimen. From the variation of pressure with temperature, the heat of transport was determined. The results varied little with composition. The heat of transport was found to increase with temperature, however, ranging from 6 to 12 kcal/mole. The thermal conductivity was found to vary with increasing temperature from 0.042 to 0.052 cal/cm/sec/°C. (auth)

13334 (BNL-627) ENGINEERING EXPERIENCE AT BROOKHAVEN NATIONAL LABORATORY IN HANDLING FUSED CHLORIDE SALTS. C. J. Raseman, H. Susskind, G. Farber, W. E. McNulty, and F. J. Salzano (Brookhaven National Lab., Upton, N. Y.). June 1960. 27p. (T-192)

Two fused chloride salt eutectics, binary LiCl–KCl and ternary NaCl–KCl–$MgCl_2$, were used in fuel processing studies as part of the Liquid Metal Fuel Reactor research and development program. Results of engineering work done at Brookhaven since 1950 are summarized. It was demonstrated that fused chloride salt technology is sufficiently developed so that loops and other experimental equipment can be designed and operated at 500°C with a high degree of confidence. The equipment, which was operated for many hours, included a large forced-circulation loop and many thermal-convection loops and tanks. The specifications used for the fabrication, cleaning, and testing of equipment for salt service are described. All welded systems, welded by the usual inert-arc procedures, are preferred, but ring type joint stainless-steel flanged connections were found satisfactory, mainly for connecting melt tanks to experimental equipment and for mounting orifice flowmeters. The surfaces of equipment to be used with fused salts were cleaned satisfactorily prior to assembly by several different methods, but sandblasting was found applicable to all types of equipment. Radiography was used to check all welds in contact with fused salt for flaws and, during operation, to locate and determine the cause of any malfunction. Components tested at the normal operating temperature of 500°C included pumps, valves, agitators, sightports, samplers, and filters. Salt samples were usually taken by the thief method. Both stationary and movable resistance type, liquid-level probes were used and were reliable so long as the salt surface remained quiescent; otherwise, splashing and short-circuiting occurred. Nullmatic, pilot-operated pressure transmitters gave good service in conjunction with both orifice and Venturi flowmeters. A procedure is described for preparing pound quantities of pure eutectics, which, in the case of the ternary eutectic, differs from that used in preparing gram quantities. Both eutectics were pretreated with a Bi–Mg–U solution to remove oxidizing impurities before use in corrosion and processing experiments. The results of physical property measurements on the two eutectics are included. (auth)

13335 (CEA-1666) NOUVELLES DÉTERMINATIONS DES TENSIONS DE VAPEUR DES ISOTOPES DU NEON. (New Determination of the Vapour Pressures of the Isotopes of Neon). Étienne Roth (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1960. 109p.

Thesis submitted to Univ. of Paris.

An experimental reinvestigation of the vapor pressures of neon isotopes at 16.4 to 30.1°K was conducted. Measure-

ments were made by differential manometry in a Giauque-Johnston type cryostat modified for temperature stability. The Ne^{20} sample contained 99.9% Ne^{20} and the Ne^{22} sample contained 72.2% Ne^{22}. Extrapolation to pure Ne^{20} and Ne^{22} can be made with sufficient accuracy by the use of Raoult's law. Results are in substantial agreement with those of Keesom and Haantjes. At 20°K, where the scatter in the data is an order of magnitude smaller than in the data of Keesom and Haantjes, $\ln P_{Ne^{20}}/P_{Ne^{22}}$ is 6% larger than the smoothed line given by them. For solid neon, data can be represented to a high accuracy by a Debye harmonic lattice with $\theta_D(Ne^{20}) = 74.6°K$. The result may be compared with the value obtained by Henshaw from the Debye-Waller temperature factor, $\theta_D = 73°K$, and with the recent calculation of the zero point energy of Ne by Bernardes, from which he obtains $\theta_D = 8E_0/9R = 73°K$. (auth)

13336 (CEA-Bib-13) DIFFUSION METAL–METAL. (Metal-Metal Diffusion). C. Pinchon (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). Nov. 1960. 22p.

This bibliography is concerned with metal-metal diffusion. It covers the period from 1950 to 1960 and includes 241 references. (auth)

13337 (CRE-996) OXIDIZED ZIRCONIUM AS A BEARING MATERIAL IN WATER-LUBRICATED MECHANISMS. R. D. Watson (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Dec. 1960. 6p. (AECL-1189)

Since oxidized zirconium in contact with 300 and 400 series stainless steels has excellent corrosion resistance and good galling resistance, the combination is suitable for use as a wear surface in water-lubricated reactor mechanisms. The oxidized zirconium surface can be prepared by heating the zirconium for 2 hr at 800°C in air, causing an oxide film 0.0007 to 0.001 in. thick to be formed. Wear tests on oxidized zirconium in contact with a variety of corrosion-resistant materials in water were performed with a journal sleeve bearing test rig. The results indicate that most of the materials tested are compatible with zirconium. (D.L.C.)

13338 (CRMet-901) A STUDY OF PREFERRED ORIENTATION IN EXTRUDED ZIRCALOY-2 PRESSURE TUBES. R. H. Tuxworth (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nov. 1960. 28p. (AECL-1174)

The preferred orientation present in large-diameter extruded Zircaloy-2 pressure tubes and, for comparison, in a relatively thick-walled tube, was investigated. The most consistent feature observed for the pressure tubes is the occurrence of the basal planes parallel to the working direction. Textures of $(10\bar{1}0)$ and $(11\bar{2}0)$ types, as well as randomness about the transverse direction, are found. The thick-walled extruded tube also exhibits a basal-plane texture. An attempt is made to explain the higher transverse yield strength as compared with the longitudinal yield strength in terms of the preferred orientation present. This treatment suggests that the preferred slip system at room temperature is of the form $(10\bar{1}0)[12\bar{1}0]$. (auth)

13339 (CRMet-988) AN ORIENTATION STUDY OF UO_2 SINGLE CRYSTALS. R. H. Tuxworth (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nov. 1960. 18p. (AECL-1170)

The crystallographic direction parallel to the major axis of columnar UO_2 crystals formed under various conditions was determined. Crystals formed from the melt have a [1 0 0] direction parallel to their major axes. Those grown from the vapor have [1 0 0], [1 1 1], or [1 1 0] directions parallel to their lengths, depending on the conditions under which they were formed. These results are discussed in connection with columnar grain formation in polycrystalline UO_2 under high-temperature gradients. (auth)

13340 (DMIC-Memo-87) A STATISTICAL SUMMARY OF MECHANICAL-PROPERTY DATA FOR TITANIUM ALLOYS. W. Stuart Lyman (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Feb. 14, 1961. 25p. (PB-161237).

A description is given, in a series of charts and histograms, of the mechanical properties of several titanium alloys under various conditions. The alloys described were produced and tested from 1957 to 1960. (B.O.G.)

13341 (DP-331) AGING OF Al-Li ALLOYS–PART I. C. L. Angerman (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1959. Declassified Aug. 4, 1960. 15p. Contract AT(07-2)-1.

Aluminum-lithium alloys are subject to precipitation from solid solutions and may be age-hardened by the same techniques used for more common aluminum alloys. Spherical particles of precipitate were observed with the electron microscope in 1.5 and 2.8% Al–Li alloys after aging for periods of time comparable to those required to produce maximum hardness. Rod-shaped particles that were oriented parallel to either the (110) or the (111) planes of the aluminum matrix were observed in overaged specimens. (auth)

13342 (GA-1906) THERMAL AND MECHANICAL PROPERTIES OF BERYLLIA CERAMICS. MARITIME GAS-COOLED REACTOR PROGRAM. Final Report [for] August 1960. (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 20, 1961. For General Atomic and Electric Boat Divisions, General Dynamics Corp. Contract AT(04-3)-187. 36p.

Results are presented of a literature search to compile thermal and mechanical properties of beryllia ceramics. Sources include Nuclear Science Abstracts, 1949 through 1959, Chemical Abstracts, 1940 through 1959, Armed Forces Technical Information Agency Abstracts, 1940 through 1958, and Ceramics Abstracts, 1940 through 1958. The information is presented tabularly. 39 references. (J.R.D.)

13343 (LAR-52) INVESTIGATION OF HYDRIDING CHARACTERISTICS OF INTERMETALLIC COMPOUNDS. First Quarterly Report, October 1, 1960 to December 31, 1960. Richard L. Beck (Denver. Univ. Denver Research Inst.). Feb. 14, 1961. Contract AT(33-3)-3. 27p.

An investigation of the hydriding characteristics of a broad range of intermetallic phases was undertaken. The experimental results obtained from 33 different intermetallic phases are presented. At least two of these compounds absorbed more hydrogen than would be possible under similar conditions by the individual elements involved. This fact lends considerable hope to the possibility of discovering hydrided intermetallic phases which will exhibit very high N_H values at elevated temperatures. (auth)

13344 (NAA-SR-4898(Rev.)) THE PERMEATION OF HYDROGEN THROUGH HASTELLOY B. D. W. Rudd and D. W. Vose (Metal Hydrides Inc., Beverly, Mass.). and J. B. Vetrano (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 15, 1961. Contract AT-11-1-GEN-8. 16p.

The flux of hydrogen gas through Hastelloy B, hot forged to 20% reduction, was determined as a function of membrane thickness, pressure differential, and temperature. The experimental data were fitted to the equation $J = (1810\,P^{1/2}/X)\exp(-8422/T)$ where J is the flux (cc at STP/

(cm^2-hr)); P is the pressure (atmospheres); X is the membrane thickness (mm); and T is the temperature (°K). (auth)

13345 (NAA-SR-5357) AN EXPERIMENTAL STUDY OF INTERMETALLIC DIFFUSION IN LARGE TEMPERATURE GRADIENTS. C. J. Meechan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1960. 18p. Contract AT(11-1)-GEN-8.

Temperature gradients in the range 2000 to 3000°C/cm were imposed across the interface of binary diffusion couples fabricated from face-centered-cubic metals. The systems investigated were Au–Ni, Cu–Ni, γFe–Ni, γFe–Pd, and Ni–Pd. It was found that chemical diffusion in these systems was influenced in varying degrees by the temperature gradient. Suggestions are given for the manner in which the temperature gradient may affect the various contributions to chemical diffusion. (auth)

13346 (NAA-SR-Memo-816) A DISCUSSION OF THE METALLURGICAL ASPECTS OF THORIUM AS A FUEL MATERIAL. B. R. Hayward (North American Aviation, Inc., Downey, Calif.). Nov. 6, 1953. Decl. Nov. 6, 1958. 14p.

Data on thorium are compiled and the use of thorium as a fuel material is discussed. It was assumed that the general reactor configuration will follow the conventional SGR-SRE reactor design of a graphite-moderated sodium-cooled metallic fuel system. Factors outlined which affect the use of thorium as a fuel material are availability of ore, capacity of processing plants, purity specifications, design and use of materials in fuel elements which may affect chemical separation, economics, and technical feasibility. General metallurgical properties of thorium are described including melting point, density, chemical purity, thermal conductivity, thermal expansion, phase transformations, corrosion in liquid metals, tensile and creep strength, dimensional stability, and alloying properties. Methods of chemical processing, fabrication, and cladding are outlined. The advantages and disadvantages in the use of thorium as a fuel are summarized. (M.C.G.)

13347 (NAA-SR-Memo-5494(Rev.A)) THE OXIDATION OF URANIUM CARBIDE. E. W. Murbach (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 14, 1960. 5p.

The oxidation of arc-melted uranium carbide is characterized by a rapid reaction, initiated at ~300°C (in oxygen), which produces an intermediate oxide (UO_{2+x}, $x < 0.67$) followed by a slower reaction in which the intermediate oxide is converted to U_3O_8. With 1 to 10 g samples heated in 10 to 700 mm O_2, initial oxidation rates (rate of weight gain) varied between 1 and 34 mg/min-g. The rates represent reaction times of minutes to approximately 1 hr for the initial oxidation step. In air at one atmosphere, initial rates were 1.5 to 2.0 mg/min-g. The oxidation of uranium carbide appears to be readily controlled by controlling the oxidizing atmosphere. Either air or a low pressure oxygen atmosphere for the initial oxidation step is recommended. (auth)

13348 (NEPA-1125) THERMAL STRESS TESTS OF KS GRAPHITE. A. R. Crocker (Fairchild Engine and Airplane Corp. NEPA Div., Oak Ridge, Tenn.). July 19, 1949. Decl. Oct. 31, 1960. 42p.

A program was initiated to determine the thermal rupture characteristics of KS graphite under steady-state operating conditions simulating the thermal conditions of an uninhibited rocket reactor. The maximum thermal stress calculated using room-temperature properties was 3090 psi. The maximum net specific power obtained was 5.2 Btu/cu in.-sec. (B.O.G.)

13349 (NP-9416) DEVELOPMENT AND EVALUATION OF HIGH TEMPERATURE PROTECTIVE COATINGS FOR COLUMBIUM ALLOYS. First Quarterly Progress Report, Period Covered April 1, 1960–June 30, 1960. R. A. Jefferys and J. D. Gadd (Thompson Ramo Wooldridge Inc., Cleveland). July 1o60. Contract AF33(616)-7215. 83p. (TM-1567-CM)

A state of the art survey was conducted to establish the status of niobium alloys and coatings. On the basis of the survey, unalloyed niobium and Nb–Ti–Mo and Nb–W–Mo–Zr alloys were selected as the base materials for coating programs. Material procurement is in progress. Oxidation, oxide melting point, transition temperature, and recrystallization measurements were made on the base materials. A discussion of coating development and evaluation procedures is included. (J.R.D.)

13350 (NP-9861) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. M. J. Wahll, comp. (Battelle Memorial Inst., Defence Metals Information Center, Columbus, Ohio). Oct. 1960. 199p.

A listing of about 600 selected articles, reports, and papers concerning Ti, Be, Mo, Nb, Ta, Cr, W, V, Re, Pt, steel, stainless steels, and alloys is presented. Author and subject indexes are included. (W.L.H.)

13351 (NP-9872) INVESTIGATION OF HIGH TEMPERATURE RESISTANCE MATERIALS. Quarterly Report No. 19, November 1, 1960–January 31, 1961. C. R. Mason, S. R. Elkins, and J. D. Walton (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract NOrd-15701. 26p.

Tests were made to determine if the porosity of slip-cast fused silica could be reduced by impregnating the surfaces with ethyl silicate or aluminum chloride, and flame glazing using a plasma flame system. Plates of the fused silica were slip cast, dried, fired, and impregnated with ethyl silicate 40 solution. This process of soaking and refining was repeated until 5 cycles were completed. The results showed that the average transverse strength was increased after each impregnation and refining cycle. The increase in strength was greater for the small plates than for the large ones. The average water absorption was decreased by approximately 2% for small plates while there was no significant decrease for large plates. Work on aluminum chloride impregnation was not completed and no results are included. Flame glazing studies were initiated. Test samples were fabricated using gypsum plastic molds. No data were obtained due to the breakdown of the F-40 arc-plasma gun. Rain erosion test plates were slip cast, dried, fired, impregnated 3 and 5 times with ethyl silicate 40, and refined after each impregnation. These plates will be shipped to the Department of the Navy, Bureau of Naval Weapons, for testing. (M.C.G.)

13352 (NP-9900) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. M. J. Wahll, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Nov. 1960. 115p.

A total of 184 references with appended abstracts is given on metals. Some of the metals included are titanium, beryllium, refractory metals, and high-strength alloys. Fabrication of these metals and their applications are treated. (D.L.C.)

13353 (OOR-2406.1) ELECTRICAL AND MECHANICAL BEHAVIOR OF AMORPHOUS MATERIALS AND THEIR RELATION TO FRICTIONAL AND LUBRICATION PHENOMENA. Final Report, September 29, 1959–September 30, 1960. Selby M. Skinner and Edward L. Kern (Case Inst. of Tech., Cleveland). Contract DA-33-019-ORD-3219. 49p.

The formation and breaking of microscopic adhesional welds involved in basic frictional phenomenon were studied in detail. The influence of charge transfer rates and effects of previous charge history were studied for a variety of polymers and copolymers. The rate of charge transfer between metal and plastics depends on composition of the metal surface, composition of the plastic surface, and the charge history of the plastic. The breaking of adhesional welds between metal and plastics was studied by analyzing the initial portions of the electrical and mechanical transients observed. A theoretical equation is proposed which satisfactorily describes the initial electrical transient observed and which shows that electron bonding makes the greatest contribution to adhesional force through mechanisms which are either chemical bonding or space charge attraction. At break, these charges produce an electrostatic force determined by the original intrinsic potential levels of the materials involved. Particular attention is given to experiments in which pressure contacts between clean metal and plastic are repeated many times to simulate in part the situation of surface conditioning which occurs upon repeated passage of metal over the same portions of plastic bearing surfaces in friction. No evidence can be found to show that wear and/or contamination of one of the contacting materials by the others has any correlation with the drift in contact-charging behavior which occurs after very many contacts. Frictional effects are analyzed in terms of the mechanisms studied and are shown to be the direct consequence of these types of material behavior. (auth)

13354 (SCTM-422-60(11)) A STUDY OF THE EFFECT OF VARIOUS FLUORIDE TREATMENTS ON THE PROPERTIES OF BARIUM TITANATE AND LEAD ZIRCONATE TITANATE POLYCRYSTALLINE FERROELECTRIC CERAMICS. David L. Wilcox (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 42p.

Property changes were observed which occur in a nondoped barium titanate body and a lead zirconate titanate $Pb(Zr_{0.56}\ Ti_{0.44})O_3$ with 1 wt.% Nb_2O_5 after a fluoride powder packing procedure. The fluoride packing procedure consisted of surrounding matured (fired) specimens of $BaTiO_3$ and PZT-XVIII (lead zirconate titanate composition) with an alkaline earth fluoride (MgF_2, CaF_2, SrF_2, and BaF_2) or PbF_2 in a closed container. The packed specimens were heated to a fluoridizing temperature and held at this temperature for soak times ranging up to 4 hr. (auth)

13355 (TID-1140) PRESSURE OF THE SHOCK-INDUCED TRANSITION IN IRON-BASE BINARY AND TERNARY ALLOYS OF CHROMIUM AND/OR NICKEL. F. Stanley Minshall, Eugene G. Zukas, and C. M. Fowler (Los Alamos Scientific Lab., N. Mex.). [1960?]. 14p.

As nickel is added to iron, the pressure of a shock-induced transition decreases monotonically from 130 to ~82 kilobars with 30% nickel. As chromium is added to iron, the pressure first decreases to ~125 kilobars with ~10% chromium, then increases rapidly to about 266 kilobars with 28.7% chromium. The pressure decreases rapidly for ternary alloys, being ~29 kilobars for an α phase alloy of 18% chromium, 8% nickel, and 74% iron. (auth)

13356 (TID-11742) DIFFUSION IN LIQUID ALLOYS. Technical Progress Report, January 1, 1960 through January 31, 1961. Richard E. Grace (Purdue Univ., Lafayette, Ind. School of Metallurgical Engineering). Jan. 31, 1961. Includes Appendix: DISSOLUTION KINETICS OF SINGLE CRYSTAL DISKS OF ZINC IN ZINC AMALGAMS. M. A. Dayananda and Richard E. Grace. Contract AT(11-1)-359. 30p.

Investigations were undertaken on liquid metal corrosion and diffusion which dealt with self diffusion of zinc in lead-zinc alloys; dissolution of single crystal disks of zinc in zinc amalgams; dissolution of rotating aluminum cylinders in liquid bismuth; rate of formation of FeSn; and the dissolution of copper in liquid lead in an isothermal loop. Four differently orientated single crystals of zinc dissolved at 1000 rpm and 50°C in zinc amalgams of the same initial zinc activity showed the anisotropy in the dissolution process. The solution rate constants for the crystals decreased with an increase of initial zinc concentration in the amalgam. A study of the influence of rotational speed on the dissolution kinetics for a crystal surface inclined at 7° with the basal plane revealed two stages of dissolution; one being surface controlled and the second being influenced by hydrodynamic conditions. (B.O.G.)

13357 (TID-11882) STRUCTURE OF LIQUID METALS. R. B. Gordon (Yale Univ., New Haven). Mar. 1, 1961. Contract AT(30-1)-2029. 14p.

The compressibilities of alloys in the liquid sodium-potassium system were measured and found to be slightly greater than the weighted average of the compressibilities of the pure components. The deviation is in the opposite direction to that predicted by free-electron theory and must be explained in terms of charge transfer effects. Several cells for Hall effect measurements on liquid metals have been constructed and tested, as yet without satisfactory results. (auth)

13358 (TID-11908) STRUCTURE AND PROPERTIES OF SOLID SOLUTIONS. Technical Progress Report No. 1 covering June 15, 1960 to March 1, 1961. A. A. Hendrickson and G. Tardiff (Michigan Coll. of Mining and Tech., Houghton). Contract AT(11-1)-916. 8p.

An investigation was made to determine the cause or causes of solid solution strengthening in certain alloys. In preliminary studies of the effect of solute additions on crystal perfections using secondary recrystallization techniques, large grains were obtained in silver sheet. However, these grains contained a number of annealing twins. Silver-base zinc crystals were grown and after annealing were tested in tension at a strain rate of 2×10^{-4}/sec. The critical resolved shear stress for silver-base zinc crystals was determined as a function of zinc content and testing temperature. Strain aging tests on silver-base zinc single crystals resulted in yield point phenomena at both 2 and 6 at.% zinc. The magnitude of the yield point was dependent on the aging time and temperature. (M.C.G.)

13359 (TID-11911) ANALYSIS OF DEFORMATION DEPENDENT STRENGTH OF MODEL SOLIDS WITH ORDERED SHORT RANGE MOLECULAR FORCES. Technical Report No. 12. J. E. Osborn, T. S. Wu, and C. C. Hsiao (Minnesota. Univ., Minneapolis. Inst. of Tech.). Aug. 1960. Contract AT(11-1)-532. 22p.

The effect of one-directional deformation on the variation of mechanical strength is analyzed for a model solid having short-range molecular forces. It is assumed that for large deformations, a certain direction in every ordered formation of a random system of linear spring elements will orient toward the direction of deformation. The three directions, [1 1 1], [1 1 0], and [1 0 0] in a cubic formation are considered. The fracture strength for each case is expressed as a function of deformation. It is found that the maximum fracture strength obtainable in the highly deformed state is six times that of the undeformed system. The strength in the direction of deformation may increase or decrease, depending upon the configuration of the ordered formation and the direction of deformation. (auth)

13360 (TID-11939) STRUCTURAL MATERIALS IN GAS-COOLED REACTOR SYSTEM. T. C. Yen (Franklin Inst. Labs. for Research and Development, Philadelphia). Feb. 1961. Contract AT(30-1)2512. 87p. (I-A2392-13)

The development of structural materials for use in gas-cooled reactor systems is surveyed. The effects of gaseous environment on the mechanical strength of structural materials are discussed. Creep-rupture data of high-temperature alloys in atmospheres of air, oxygen, helium, and in a vacuum showed generally that creep resistance and rupture life were greater in air than in the other atmospheres. The effects of impurities in the gases were also investigated. Physical, mechanical, nuclear, and thermal properties are given for three classes of structural materials: stainless steels, nickel-base alloys, and refractory metals. Methods of fabrication are described. (M.C.G.)

13361 (UCRL-9494) EXPERIMENTS ON COLOR CENTERS IN CRESTMORE BLUE CALCITE. (thesis). Alice Wiersema (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 9, 1960. Contract W-7405-eng-48. 34p.

Color centers in blue calcite from the Crestmore region of California were studied by electron spin resonance. A spectrum of four equally spaced lines is obtained in addition to the spectrum of thirty lines due to manganese. This quartet extends over a range of about 30 gauss and is centered about a g value of 2.013. The spectrum of powdered calcite shows a variation of line width with magnetic field. By using the theory of McConnell—which relates the paramagnetic relaxation times, T_1 and T_2', the hyperfine interaction, and the corelation time, τ_c with the anisotropy of the g value—Δg is calculated as 0.002. From thermoluminescence studies of the blue calcite three glow peaks are obtained, at 52, 170, and 262°C. The peak at 262°C is obtained only with blue calcite. It occurs at the temperature at which the sample bleaches, and is related to the color centers. Spectrochemical and quantitative chemical analyses were made to determine what impurities are responsible for the color centers. From consideration of the spectroscopic g value and the hyperfine splitting it is probable that the color centers are due to a cationic impurity with nuclear spin 3/2. (auth)

13362 (WADD-TR-60-425) MECHANICAL PROPERTIES OF BERYLLIUM. A. E. Riesen and R. T. Ault (Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio). Sept. 1960. 35p. (AD-249393)

The test procedures and results of a mechanical properties determination program that included tensile, torsion, pin shear, creep rupture, and fatigue data on two lots of beryllium are presented. One lot of material with a BeO content of 1.45% was hot-pressed; the other lot, containing 1.55% BeO was hot-pressed and hot-extruded. Emphasis was placed on the fatigue and creep-rupture data. Fatigue tests were conducted at room and elevated temperatures with stress ratios of A = ∞ and 0.67. Both lots of material showed surprising strength under fatigue loading conditions although beryllium's inherent brittleness manifested itself under static loading conditions by brittle factures. The hot-pressed hot-extruded material was uniformly stronger and therefore more desirable for design purposes than the material that was only hot-pressed. (auth)

13363 (WADD-TR-60-451) EFFECT OF THERMAL-MECHANICAL VARIABLES ON THE PROPERTIES OF MOLYBDENUM ALLOYS. M. Semchyshen, Robert Q. Barr, and Gordon D. McArdle (Climax Molybdenum Co. of Michigan, Detroit). Nov. 1960. Contract AF 33(616)-5447. Project No. 7351. 120p.

Unalloyed molybdenum and the alloys Mo–0.50% Ti, Mo–0.059% Zr, and Mo–0.49% Ti–0.057% Zr, were studied from the standpoint of effect of fabrication variables on mechanical properties and structural stability. Strain hardening was accomplished either by rolling or by forging. Working temperatures were 2200 and 3000°F. Molybdenum and the alloys were capable of being strain hardened even at low reductions by rolling or forging at 3000°F. For any given set of deformation variables, the highest strength properties and greatest resistance to recrystallization were consistently demonstrated by the ternary alloy Mo–0.49% Ti–0.057% Zr. The role of externally applied stresses in influencing the recrystallization behavior of the materials under investigation was found to be quite complex. At least part of the complexity of the problem as approached here resulted from the large number of fabrication variables that were inherent in the test specimens. Four new experimental alloy compositions are discussed. (auth)

13364 (WADD-TR-60-705) THE INFLUENCE OF PRESSURE AND TEMPERATURE ON ZIRCONIUM OXIDE. F. W. Vahldiek, C. T. Lynch, and L. B. Robinson (Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio). Nov. 1960. 32p.

The effects of temperature and pressure on the monoclinic-tetragonal-phase transformation and on the sinterability of superpure zirconia were studied. Investigations were undertaken at 1140 to 1800°C and at 310 to 12,380 atm. Experiments showed that no tetragonal phase was stabilized after firing and rapid quenching in air, water, and liquid nitrogen. The region of transformation was found at 1193 to 1200°C. Pressure lowered the sintering temperature of zirconia, and specimens pressed at 9280 atmospheres and fired to 1800°C in an inert atmosphere resulted in compacts with a 98.8% theoretical density. Grain refinement was observed with increasing temperature and at various pressures. Average particle sizes of 4 μ and less were found in compacts originally consisting of particles averaging 60 μ. A mathematical equation for the compressibility of zirconia was derived. (auth)

13365 (WAPD-BT-21(p.33-42)) AN X-RAY DIFFRACTION STUDY OF IRRADIATED FLUORITE-TYPE MATERIALS. R. M. Berman (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

X-ray-diffraction patterns were obtained from UO_2, UO_2 solid solutions, ZrO_2, and CaF_2 which had undergone various degrees of pile irradiation; these materials, for the most part, gave the pattern of single, cubic, fluorite type phases, showing little or no change in unit cell size from unirradiated material. ZrO_2 and ZrO_2–UO_2 solid solutions with distorted fluorite type structures went to a higher symmetry when irradiated with fission fragments. The UO_2 structure remained stable up to 20×10^{20} fissions/cm^3; at some slightly variable point beyond this, it gradually became amorphous, although the remaining crystalline portions continued to give a cubic pattern as high as 30×10^{20} fissions/cm^3. (auth)

13366 (WAPD-BT-21(p.43-9)) DETERMINATION OF CHARPY-V NOTCH ENERGY VALUE AT THE DROP WEIGHT AND PRECRACK CHARPY NIL-DUCTILITY-TRANSITION TEMPERATURE FOR TYPE 410 STAINLESS STEEL. R. E. Myers and A. Feduska (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Mechanical tests on 1150°F tempered type 410 stainless steel were conducted to establish a Charpy-V notch impact energy fix that would correlate closely with drop weight and precracked Charpy determinations of nil ductility transition

temperature (NDT). Results of these tests indicate that a 30 ft-lb fix is a realistic criterion for estimating the NDT temperature. Utilization of the 30 ft-lb energy fix would reduce the possibility of accepting inadequate material without imposing unduly stringent requirements for acceptance. (auth)

13367 (WAPD-BT-21(p.51-8)) MECHANICAL PROPERTIES OF VACUUM MELTED CONSUMABLE ELECTRODE TYPE 403 STAINLESS STEEL AFTER TEMPERING AT 1150°F. R. E. Myers and J. V. Alger (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

Mechanical tests were conducted to investigate the possible advantages in using vacuum consumable-electrode (consutrode) melting of type 403 (410) stainless steels for control-rod drive-mechanism motor-tube construction. The mechanical properties of consutrode type 403 stainless steel were determined by using tensile and Charpy-V notch impact tests. Drop weight tests and precracked Charpy impact tests were utilized to determine the nil ductility transition temperature for this material. None of the three heats of consutrode material tested met all the minimum mechanical properties presently required for control-rod mechanism motor-tube type 403 stainless steel in the 1150°F temper, and, because of this lack of improvement in mechanical properties and the increased cost of consutrode material, it is concluded that its substitution for air-melted type 403 stainless steel is not warranted. (auth)

13368 (AEC-tr-4535) ATOMIC STRUCTURE OF SOLID CHROMIUM SOLUTIONS IN NICKEL. Yu. (Iu.) Bagaryatskii and Yu. (Iu.) D. Tyapkin. Translated from Doklady Akad. Nauk S.S.S.R., 122: 806-9(1958). 8p. (includes original, 4p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 3028.

13369 ((HW-tr-24) GRAIN REFINING OF URANIUM BY MEANS OF SMALL ADDITIONS AND HEAT TREATMENTS. H. Aubert and J. Gerland. Translated by Liz Appleby from Mém. sci. rev. mét., 56: 393-402(Sept. 1959). 19p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 3775.

13370 (NP-tr-567) THE STRUCTURE AND PHASE COMPOSITION OF DIFFUSION COATING OF NIOBIUM BY SILICON. P. M. Arzhanyi (Arzhanyy), R. M. Volkova, and D. A. Poroshkin (Prokoshkin). Translated from Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 6, 127-9(1959). 9p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 19458.

13371 (NP-tr-569) ALLOYS OF TRANSITION-METAL BORIDES WITH OTHER METALS. M. S. Koval'chenko, G. V. Samsonov, and G. A. Yasinskaya. Translated from Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 2, 115-19(1960). 10p.

To study the possibility of improving transition metal borides by adding other metals as binders, alloys of the pseudobinary systems ZrB_2-Mo, TiB_2-Mo, CrB_2-Mo, TiB_2-Cr, and ZrB_2-Cr were investigated. Measurements were made according to the visual thermal method on the following properties: shrinkage, melting point, and phase micro- and macro-hardness. Metallographic and radiographic examinations also were made. Hypothetical phase diagrams were constructed for the systems studied. (D.L.C.)

13372 (NP-tr-571) URANIUM ALLOY BASE NUCLEAR FUELS. Bohumil Prenosil. Translated from Jutnicke listy 13: 324-30(1958). COATING OF REACTOR FUEL ELEMENTS. Bohumil Prenosil. Ibid. 330-4(1958). 37p.

Uranium alloys are discussed with respect to radiation effects on their properties and to desirable properties for reactor use. Low-alloyed uranium alloys offer the advantages of restricted irradiation growth in one direction and reduced surface roughness, and some of the alloys considered are U–Cr, U–Al, U–Mo, U–Zr, and U–Nb, for which phase diagrams are presented. The roles of the uranium α, β, and γ phases and heat-treatment are treated. Dispersion type fuel elements offer the advantage of reduced grain, and the size and separation of the fissile particles in such elements are discussed in relation to the range and build-up of fission products. The production of a dispersion of UO_2 in aluminum is briefly considered. Multialloyed molybdenum and zirconium alloys and uranium–UC cermets are discussed. The properties of various fuel-element coatings in contact with the fuel metal and coolant and at high temperatures are discussed. The interface reactions of aluminum and uranium and the corrosion resistance of aluminum and its alloys are considered. The resistance of magnesium alloys to oxidation and ignition in CO_2 is studied. The grain problem in fabrication of magnesium alloys is considered. Zirconium alloys are treated in detail; the protective effect of the oxide film and the destructive effects of various impurities, especially nitrogen, on this protective film are discussed. Tin has a beneficial effect in that it depresses the effect of the nitrogen content. The interface reactions of zirconium with uranium are studied. Because of its high creep strength and corrosion resistance to liquid sodium, austenitic 18-9 stainless steel is often used in preference to zirconium alloys for coatings. It is concluded that the following coatings are suitable for the following reactors: (1) zirconium alloys for boiling- and pressurized-water reactors, (2) magnesium alloys for CO_2-cooled reactors at 400 to 450°C, and (3) austenitic 18-9 steel for liquid-sodium-cooled reactors at ~500°C. (D.L.C.)

13373 (UCRL-Trans-641(L)) THE ABSORPTIVITY OF PLATINUM METALS FOR HYDROGEN. Erich Müller and Kurt Schwake. Translated from Z. Elektrochem., 35: 165-84(1929). 62p.

The mechanism of platinum catalysis of formic acid in aqueous solution was explained by assuming that platinum takes up the hydrogen and frees carbonic acid. In examining the validity of this conception, the absorptivity of platinum metals for hydrogen under similar conditions, that is, in the state of formation from their compounds, was measured. In general it was found that, at the moment of formation, the platinum metals absorb more hydrogen than if they are saturated with hydrogen after separate preparation. Results indicate that the same mechanism prevails in formic acid decomposition because the metal surface is in a highly disperse form. The rate of decrease of catalysis activity with palladium was attributed to preferential aggregation, which develops in that metal upon reduction. (J.R.D.)

13374 (UCRL-Trans-644(L)) INFRARED SPECTROSCOPY IN CERAMICS WITH SPECIAL CONSIDERATION OF THE REACTIONS IN THE SYSTEM $BaO-Al_2O_3-SiO_2$. H. Muller-Hesse, E. Planz, and H. E. Schwiete. Translated from Sprechsaal, 93: 159-63(1960). 16p.

The use of infrared spectroscopy in the examination of ceramic reactions is discussed. By this method, the progress of the reaction may be followed continuously and all intermediate-phases and defective-order states observed. An infrared study of reactions in the system $BaO-Al2O_3-SiO_2$ is presented. (M.C.G.)

13375 THE PHASE DIAGRAM OF THE SYSTEM $SrCl_2$-$BaCl_2$. A. Schei and H. Flood (Technical Univ. of Norway, Trondheim). Acta Chem. Scand., 14: 2067-70(1960). (In English)

The liquidus curve of the system $SrCl_2-BaCl_2$ was determined by thermal analysis and by high-temperature filtration and the solidus, by a tracer technique previously described. The system showed complete miscibility in both liquid and solid phases, with a freezing-point minimum of 852.0°C at about 68 mole % $SrCl_2$. By assuming ideal behavior of the liquid mixtures and positive deviations with symmetrical activity coefficients of the type $RT \ln \gamma_A = b N_B^2$ for the solid mixtures, it is shown that, with a value of $b \cong 1$ kcal, a phase diagram can be calculated which gives fairly good agreement with the experimental values. (auth)

13376 THE CRYSTAL STRUCTURE OF $Ru_{11}B_8$. Jan Aselius (Univ. of Uppsala). Acta Chem. Scand., 14: 2169-76 (1960). (In English)

The crystal structure of $Ru_{11}B_8$ was determined by single-crystal methods. The orthorhombic unit has the following dimensions: a = 11.60_9 A, b = 11.34_2 A, and c = 2.83_6 A. There are two formula units in the elementary cell, and the space group is Pbam–(D_{2h}^2) No. 55. The twenty-two ruthenium atoms are situated in one twofold position and five fourfold positions, with two ruthenium atoms in 2(a); twelve ruthenium atoms in three fourfold positions 4(g); x_{II} = 0.2844 y_{II} = 0.3913, x_{III} = 0.0429 y_{III} = 0.3952, and x_{IV} = 0.1686 y_{IV} = 0.1740; and eight ruthenium atoms in two fourfold positions 4(h); x_V = 0.4636 y_V = 0.2962, and x_{VI} = 0.3404 y_{VI} = 0.0616. The sixteen boron atoms are also situated in fourfold positions with four in 4(g); $x_{II} = 0.34_{78}$ $y_{II} = 0.21_{56}$, and twelve in 4(h); $x_I = 0.13_{98}$ $y_I = 0.01_{81}$, $x_{III} = 0.15_{23}$ $y_{III} = 0.32_{65}$, and $x_{IV} = 0.27_{99}$ $y_{IV} = 0.25_{35}$. (auth)

13377 THE CRYSTAL STRUCTURE OF Hf_2Al_3. Lars-Erik Edshammar (Univ. of Stockholm). Acta Chem. Scand., 14: 2244(1960). (In English)

In phase studies of aluminum–hafnium systems the crystal structure of Hf_2Al_3 was determined. The single crystal and Guinier powder data showed the structure to be orthorhombic with the following unit cell dimensions: a = 9.52, b = 13.76, and c = 5.52 A. The space-group was found to be Fdd2 (No. 43). (M.C.G.)

13378 NEUTRON DIFFRACTION INVESTIGATION OF SOLID SOLUTIONS $AlTh_2D_n$. J. Bergsma (Joint Establishment for Nuclear Energy Research, Kjeller, Norway), J. A. Goedkoop, and J. H. N. van Vucht. Acta Cryst., 14: 223-8 (Mar. 10, 1961). (In English)

Solid solutions of composition $AlTh_2D_n$, with n = 0, 2, 3, 4, were studied by means of neutron diffraction. For n = 4 the deuterium atoms completely fill a set of equivalent Th-tetrahedra, quite similar to the arrangement in thorium hydride. For the other compositions these sites are partly occupied. No evidence for ordering has been found, even at a temperature of 82°K. (auth)

13379 THE BERYLLIUM–BORON SYSTEM. Donald E. Sands, Carl F. Cline, Allan Zalkin, and Clarence L. Hoenig (Univ. of California, Livermore). Acta Cryst., 14: 309-10 (Mar. 10, 1961). (UCRL-6035-T). (In English)

The preparation and study of single crystals of BeB_2 and 'BeB_6' is reported. The samples were prepared by sintering pressed powder mixtures in BeO crucibles under Ar, followed by homogenization at 1400 to 1600°C. Powder patterns (using the Cu Kα 1.5418 A radiation) and chemical analyses are given for BeB_2 and 'BeB_6'. Powder patterns are given for 'Be_6B' and Be_2B. (T.R.H.)

13380 THE STRUCTURE OF CRYSTALLINE URANIUM. A. H. Cash, Edward W. Hughes, and Carleton C. Murdock (Cornell Univ., Ithaca, N. Y.). Acta Cryst., 14: 313-14(Mar. 10, 1961). (In English)

A study was made to test the notion that powder data for structure determinations would be more useful if photographs were made with as many different consecutive Kα wavelengths as possible so that as much of the diffraction pattern as possible could be observed in the high-resolution back-reflection region of the camera. Photographs were prepared in a vacuum precision camera using all the wavelengths from Zn to Cr. The structure, except for small differences in bond lengths is the same as that described by Jacob and Warren, J. Am. Chem. Soc. 59, 2588 (1937). (T.R.H.)

13381 ON THE UNIT CELL OF MALLINCKRODT'S UO_3. P. M. de Wolff (Technische Hogeschool, Delft, Netherlands). Acta Cryst., 14: 322-3(Mar. 10, 1961). (In English)

A new interpretation is offered for the data of Connolly, Acta Cryst. 12, 949 (1959), based on the quadratic form $10^4 \sin^2\theta = q = 124.75(h^2 + k^2) + 2.5hk + 14.95l^2$, with h + k + l even. Positive features of the present interpretation are: the split lines stand out unambiguously as hkl,hk$\bar{l}$ doublets caused by pseudosymmetry; the number of molecules in the body-centered unit cell is Z = 16; the lattice is actually face centered orthorhombic with a unit cell twice as large as the body-centered monoclinic unit cell; in the body-centered description, the indices of all indexable lines follow the rather severe special restrictions of the space-group $I4_1/amd$. (T.R.H.)

13382 ON THE STRUCTURE OF URANIUM IN THIN FILM. Jerry Donohue (Univ. of Southern California, Los Angeles). Acta Cryst., 14: 327(Mar. 10, 1961). (In English)

A thin film of U, obtained by evaporation of a weighed quantity of the metal from a W bucket inside a vacuum chamber (10^{-4} mm Hg) on to a collodion film covering a steel wire mesh was examined by the electron diffraction method by Chatterjee, Acta Cryst. 11, 679 (1958). Other data are cited to show that the material used was not β-U, as reported, nor was it α-U, γ-U, UO_2, U_3O_8, UC, or UN. (T.R.H.)

13383 A NEW PHASE IN THE ZINC–ZIRCONIUM SYSTEM. D. R. Peterson and H. W. Rinn (Dow Chemical Co., Midland, Mich.). Acta Cryst., 14: 328-9(Mar. 10, 1961). (In English)

An intermetallic compound Zn_2Zr_3 was isolated by precipitation from a solution of Zn and Zr in molten Mg. A representative sample contained 68.0 wt.% Zr and showed a density of 6.60 ± 0.04 g/cc. Data indicate a simple tetragonal unit cell with edges a = 7.633 ± 0.004, c = 6.965 ± 0.004 A, c/a = 0.9125. Powder data are listed. (T.R.H.)

13384 BORIDES AND SILICIDES OF THE TRANSITION METALS. Bertil Aronsson (Univ. of Uppsala). Arkiv Kemi, 16: 379–423(1960). (In English)

A study was made of the borides and silicides of the transition elements with particular emphasis on their crystal chemistry. The crystallographic constants of borides, silicides, and silico-borides are critically reviewed. Physical and chemical data are presented and compared with those of carbides and nitrides. In particular, the connection between trends in the thermodynamic properties of these phases and changes of equilibria during systematic substitution of the transition elements is considered. Finally, the relation of borides and silicides to the typical interstitial phases, carbides and nitrides, as well as theoretical speculations on the "bonding" in these phases is discussed. (N.W.R.)

13385 STRUCTURE OF U_4O_9. Bella Belbeoch, Claudia Piekarski, and Pierre Perio (Centre d'Etudes

Nucléaires, Saclay, France). Bull. soc. franc. mineral. et crist., 83: 206-8(1960). (In French). (CEA-1753)

The structure of U_4O_9 was determined with powders and monocrystals by x-rays and neutrons. The structure was obtained by regular insertion of oxygen into the c.f.c. CaF_2 type structure of the UO_2. This process leads to a complex superstructure having a 4 by 4 by 4 pseudonetwork of 5.443 Å. The space group was $I\bar{4}3d$ with $a = 4\ a_0 = 21.77$ A. These were 832 atoms in the unit cell distributed among 23 Wyckoff positions of which only two were particular. The elaboration of this structure defined by 43 parameters is very difficult with the usual calculation methods. (auth)

13386 THE DIFFUSION OF SOME METALS PRESENT AS A DILUTE SOLUTION IN URANIUM. Michel Mossé, Viviane Lévy, and Yves Adda. Compt. rend., 250: 3171-3 (May 9, 1960). (CEA-1608). (In French)

By means of experiments carried out in a heterogeneous system, the diffusion of iron, nickel, chromium, and silicon in uranium was studied. By comparison of the diffusion constants as measured with values obtained previously, it is shown that the diffusion coefficient decreases as the atomic radius of the solute increases. (auth)

13387 SOME REGULARITIES IN THE ELECTRIC PROPERTIES OF BORIDES, CARBIDES AND NITRIDES OF TRANSITION METALS WITHIN THE IV-VI GROUPS OF THE PERIODIC SYSTEM. S. N. L'vov, V. F. Nemchenko, and G. V. Samsonov (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, USSR and Krupskaya Kherson Pedagogical Inst., [USSR]). Doklady Akad. Nauk S.S.S.R., 135: 577-80(Nov. 21, 1960). (In Russian)

The Hall coefficient, thermoelectromotive force, and specific electroresistance of monocarbides, nitrides, and diborides of IV- to VI-group metals were measured. Data are tabulated for Ti, Cr, Nb, Hf, W, V, Zr, Mo, and Ta. It is shown that while the Hall coefficient of all metals (except Ti) is generally positive; in combination with boron, carbon, and nitrogen it is negative. In the transition from group IV to V or VI, the minus sign changes to plus. Also, the specific electroconductivity (ρ) in most diborides is less than in carbides. In nitrides of group IV, ρ is smaller than in nitrides of group V. A detailed analysis is made of the electrophysical properties of the compounds. (R.V.J.)

13388 X-RAY SPECTRAL STUDY OF TITANIUM BERYLLIDES. E. E. Vaĭnshteĭn, E. A. Zhurakovskiĭ, and I. B. Staryĭ (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR and Uskinskii Odessa Pedagogical Inst., [USSR]). Doklady Akad. Nauk S.S.S.R., 135: 642-4(Nov. 21, 1960). (In Russian)

The fine structure of the x-ray spectra of titanium beryllides was studied in TiBe and $TiBe_2$. The obtained spectrograms are discussed. (R.V.J.)

13389 DIFFUSION COEFFICIENTS OF IONS IN MOLTEN SLAGS. V. I. Musikhin and O. A. Esin (Inst. of Metallurgy, Ural Branch, Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 136: 388-90(Jan. 11, 1961). (In Russian)

Diffusion coefficients of Fe, Co, Si, Nb, V, Ti, and Zr in aluminate slag (45% CaO, 47% Al_2O_3, 6% MgO, and 2% B_2O_3) and Ni, Fe, V, and Nb ions in silicate melts (40% CaO, 40% SiO, and 20% Al_2O_3) are plotted on coordinates lg D, 1/T. Two distinct groups were observed. The diffusion coefficients for Fe, Co, and Ni are about 20 times larger than for the grid forming elements such as Si, Nb, V, Ti, and Zr. (R.V.J.)

13390 THE INFLUENCE OF TENSILE AND PLASTIC DEFORMATION ON K PHASE FORMATION IN Ni–Cr ALLOYS. L. E. Popov and G. I. Karpov (Siberian Inst. of Physics and Tech., Kuibyshev Tomsk State Univ., [USSR]). Izvest. Vysshikh Ucheb. Zavedeniĭ, Fiz., No. 2, 111-13 (1960). (In Russian)

K-phase formation in nickel alloys with 1.66 wt.% chromium under stress and load in elastic and plastic deformation was studied. It was found that plastic deformation plays a more important part than elastic stress. (tr-auth)

13391 WEAR RESISTANCE OF DURALUMIN TO ABRASIVE PARTICLES DURING AGE HARDENING. V. N. Kashcheev (Siberian Inst. of Physics and Tech., Kuibyshev Tomsk State Univ.). Izvest. Vysshikh Ucheb. Zavedeniĭ, Fiz., No. 2, 235-6(1960). (In Russian)

Results show that increased deformation in Duralumin during age hardening and after annealing increases the wear resistance to flowing abrasive particles. (R.V.J.)

13392 ON THE NEGATIVE STRESS RELAXATION IN NICKEL. L. M. Butkevich (Siberian Inst. of Physics and Tech., Tomsk State Univ.). Izvest. Vysshikh Ucheb. Zavedeniĭ, Fiz., No. 5, 64-8(1960). (In Russian)

Stress relaxation in pure nickel (99.8%) was studied after stressing at rates up to $\epsilon = 8\%$ at various temperatures. Sudden changes in deformation at 150 to 300°C and anomalous rate dependence of the flow curve at 200°C were observed, as well as negative relaxation at 200 to 250°C. Contraction and reduced volume, caused by the disappearance of vacancies and better admixture diffusion, explain the negative relaxation. (R.V.J.)

13393 PHASE EQUILIBRIA IN THE SYSTEM BeF_2–UF_4–ThF_4. C. F. Weaver, R. E. Thoma, H. A. Friedman, and G. M. Hebert (Oak Ridge National Lab., Tenn.). J. Am. Ceram. Soc., 44: 146-7(Mar. 1961).

A report is given of the phase equilibria for the ternary system BeF_2–ThF_4–UF_4. Temperatures varied from 500 to 1100°C. (T.F.H.)

13394 MONOCLINIC-TETRAGONAL TRANSITION OF ZIRCONIA. C. T. Lynch, F. W. Vahldiek, and L. B. Robinson (Wright Air Development Div., Wright Patterson AFB, Ohio). J. Am. Ceram. Soc., 44: 147-8(Mar. 1961).

An investigation of the polymorphism of zirconium oxide is described. The room-temperature stable monoclinic form undergoes a reversible transition into the tetragonal form near 1200°C. The thermal-shock resistance is low near the transition point, and therefore the transition temperature is analyzed by quenching pelletized samples of the zirconium oxide under high pressures. Cracking of the pellets is not observed below 1193°C, and above 1200°C all pellets crack upon quenching. The monoclinic ⇌ tetragonal transition temperature is then induced to be between 1193 and 1200°C. The effects of sample purity are discussed. (T.F.H.)

13395 LAYER GROWTH DURING INTERDIFFUSION IN THE ALUMINUM–URANIUM ALLOY SYSTEM. L. S. Castleman (General Telephone & Electronics Labs., Inc., Bayside, N. Y.). J. Nuclear Materials, 3: 1-15(Jan. 1961). (In English)

Interdiffusion in the aluminum–uranium system was investigated over the temperature range 400 to 600°C and the pressure range 1¼ to 10 tsi for diffusion times of 24 hr and less. The pressure-induced increase in UAl_3 layer thickness has been confirmed. Interesting correlations are shown to exist between annealing time, annealing temperature, and applied pressure on the one hand, and the nature and distribution of structural defects in the UAl_3 diffusion zone on the other. It is demonstrated that the solubility range within the UAl_3 phase must be at least 2.6 at.%

uranium. It is shown that the growth of the UAl_4 and UAl_2 phases in incremental couples is much slower than the growth of UAl_3 in aluminum–uranium couples. Finally, it is proposed that the effect of pressure on UAl_3 layer growth is primarily mechanical in that higher pressures repress the tendency for the formation of macroscopic voids and thus effectively increase the cross-sectional area available for interdiffusion. (auth)

13396 SOME ASPECTS OF THE GROWTH OF DIFFUSION LAYERS IN BINARY SYSTEMS. G. V. Kidson (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nuclear Materials, 3: 21-9(Jan. 1961). (In English)

It is shown that the application of Fick's First law to polyphase diffusion in binary systems leads to simple but rigorous expressions for the interface positions as functions of time and temperature. Systems of two and three phases are treated, and the results are generalized to an n-phase system. Some aspects of the temperature behavior of the rate constants are considered. In particular, the conditions are defined under which the phases may or may not grow to observable widths in the diffusion zone. (auth)

13397 THE EFFECT OF THE $\alpha \rightarrow \beta \rightarrow \alpha$ PHASE TRANSFORMATION ON THE PREFERRED ORIENTATION OF α URANIUM. B. R. Butcher and D. Baverstock (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nuclear Materials, 3: 30-40(Jan. 1961). (AERE-R-3217). (In English)

Dilatometric, metallographic, and x-ray observations were made on specimens of rolled uranium rod subjected to varying amounts of transformation into the β phase in a temperature gradient. The results show that the phase change is accomplished by a transformation band of mixed α and β phases passing through each specimen and that the amount of the loss of preferred orientation is a function of the degree of transformation. A mechanism to account for this is discussed. (auth)

13398 EFFECT OF ORIENTATION AND TEMPERATURE ON THE MODES OF DEFORMATION OF URANIUM. R. O. Teeg (Central Research Labs. of Texas Instruments, Dallas) and R. E. Ogilvie. J. Nuclear Materials, 3: 81-8 (Jan. 1961). (In English)

Slip in alpha uranium on the {1 1 0} at –196°C was established by two-surface analysis, and the slip direction was determined to be the <0 0 1>. Some evidence is presented which permits the postulation that the mechanism involves a movement in two <1 1 2> directions to produce an overall slip direction of <0 0 1>. The critical shear stress for {0 1 0} <1 0 0> slip and cross-slip was found to increase substantially relative to other mechanisms at low temperature. A direct confirmation of the <1 0 0> slip direction was obtained by the disappearing trace method. Kinking on the (1 0 0) plane was observed to take a number of forms. Kink bands as narrow as 5 μ and as thick as 100 μ were observed, as well as a new microkinking mechanism. The axis of rotation for kinking was confirmed to be the <0 0 1> direction. Twinning on the {1 3 0}, {1 7 6}, and {1 7 2} planes was observed, with the {1 3 0} plane by far the most active at both –196 and 350°C. Areas of operability were consistent with theoretical predictions. No new twin planes were observed. (auth)

13399 PLASTIC ANISOTROPY AND FRACTURE IN BERYLLIUM. A. P. Green and J. Sawkill (Tube Investments Research Lab., Cambridge, Eng.). J. Nuclear Materials, 3: 101-10(Jan. 1961). (In English)

The relation between plastic anisotropy and ductility in beryllium between 20 and 400°C is explored. Features of the plastic deformation and fracture of single crystals are discussed. They include basal slip, bend plane formation and splitting, crack initiation, and propagation. Comparison is made with basal fracture observed in zinc, and Stroh's theory for this type of fracture is applied to beryllium. The deformation and fracture of a polycrystalline aggregate is also discussed, and a qualitative explanation is proposed for the increase in ductility with temperature. Possible means of improving ductility are suggested. (auth)

13400 IMPROVED MECHANICAL PROPERTIES AND ASSOCIATED CONSTITUTIONAL CHANGES IN COMMERCIALLY PURE INGOT BERYLLIUM AS AFFECTED BY HEAT TREATMENT ABOVE 700°C. A. Moore (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nuclear Materials, 3: 113-14(Jan. 1961). (In English)

Beryllium behaves according to established principles for metals and alloys and hence is not an unusual metal. Its low ductility is associated with a classical ductile–brittle transition at >20°C, and its ductility minimum at 600°C is due to a precipitation aging process. For beryllium containing 0.04 to 0.4 wt.% iron, its ductility at 600°C can be increased from 15 to 70% by heat-treatment at 800°C for 120 hr. It is only after overaging that maximum ductilities are obtained. With a high impurity content, an overaged condition can be obtained by annealing at a higher temperature for a shorter time than for a lower impurity content alloy. Fracture in such overaged samples is fibrous as compared with brittle and intergranular fracture in aged samples. The position of the precipitated impurity phase in these fractures is discussed. The solution-treated state is shown to be metastable between 20 and 900°C and to approach equilibrium only after heating at ≥900°C and cooling slowly. It is believed that the initial segregation of solute and associated precipitation aging or hardening near grain boundaries or on cleavage planes cause premature failure in these regions and that in the overaged state the matrix softening is responsible for the increased ductility. (D.L.C.)

13401 THE RECRYSTALLIZATION OF URANIUM DURING COLD OR HOT FORGING. J. A. Sabato (Comision Nacional de Energia Atomica, Buenos Aires) and R. W. Cahn. J. Nuclear Materials, 3: 115-19(Jan. 1961). (In English)

Uranium forging to 50 to 70% reduction in a 3-mm thickness was carried out either cold or hot, and the forged samples were examined by micrography, macrohardness, microhardness, and x-ray-diffraction measurements. In cold-forged specimens central bands of recrystallized grains appeared with the grain diameter diminishing toward the band edges. From the microhardness data it is suggested that the central bands are more heavily deformed than the specimen taken as a whole. When a cold-forged specimen was briefly annealed, an equiaxed, rather fine recrystallized structure resulted, and the bands disappeared. Specimens hot-forged at 550°C and quenched instantaneously showed localized, very fine recrystallization, whereas specimens hot-forged and then held for a few seconds or longer before quenching showed coarse structure. (D.L.C.)

13402 SINTERED REACTOR MATERIALS. Metal Ind. (London), 98: 49-50(Jan. 20, 1961).

Aluminum plus boron or rare-earth oxides was fabricated into a homogeneous ductile material with improved physical properties by the Sinterwrought process. This powder metallurgy fabrication technique gives a product so dense that its physical properties equal or exceed those of a cast or wrought alloy of the same composition. The prod-

ucts consist of a high-melting phase uniformly dispersed in a metal or alloy matrix. A tolerance of ±0.01% may be obtained with a dispersoid content of about 5.0%. The material produced is very ductile and possesses excellent physical properties. (M.C.G.)

13403 IMPROVED NIOBIUM ALLOYS. Metal Ind. (London), 98: 52(Jan. 20, 1961).

A group of niobium alloys containing tungsten and titanium were developed in an effort to improve the strength and oxidation resistance of niobium. Maximum oxidation resistance in niobium–tungsten–titanium alloys was obtained through a compositional range of 5 to 15% titanium by weight and in excess of 15% tungsten by weight. The alloys were found to be fabricable and to have ultimate tensile strengths in excess of 40,000 lb/in.^{2} at 1204°C. The effects of additions of other elements such as vanadium, molybdenum, chromium, and zirconium were also investigated. (M.C.G.)

13404 BASIC PRINCIPLES OF THE DIFFUSION OF CARBON IN IRON. S. Z. Bokshtein, I. E. Kontorovich, and L. M. Moroz. Metalloved. i Termicheskaya Obrabotka Metal., No. 1, 10-14(Jan. 1961). (In Russian)

Studies by radioisotopic techniques, surface effects, and the location of grain boundaries cause definite nonuniform behavior in the diffusion process in metals. During the diffusion of carbon in α- and γ-iron between 550 and 950°C, the carbon had the tendency of becoming enriched at the grain boundary as a result of the great difference between the diffusion coefficients at the boundary and within the grain. Alloying additions changed the diffusion rate and the character of the carbon distribution within the metal. Elements that attached themselves to the γ-region enhanced the depth of the penetration of carbon at the expense of the boundary type diffusion; as a result, the concentration difference between the boundary region and the body of the grain was smaller in the alloyed ferrite than in the unalloyed iron. The tests were performed by covering the surface of the metal under study with $BaCO_3$ containing C^{14} and detecting the diffusion rate by autoradiography. (TTT)

13405 STRUCTURAL CHANGES IN TECHNICAL IRON BY AGING. Yu. A. Skakov (Moscow Steel Inst.). Metalloved i Termicheskaya Obrabotka Metal., No. 1, 15-19(Jan. 1961). (In Russian)

The effect of aging after rapid cooling on industrial iron alloys containing 0.01 to 0.1% carbon and 0.005 to 0.045% nitrogen was investigated by several methods, including determination of hardness changes by electron microscopy and x-ray diffraction. At low concentrations the hardness versus aging time curve at 100°C had a simple shape but at higher concentrations it presented a double maximum; the fine structure of the matrix underwent a change at the same time, as determined by the widening of the spectral lines as a function of the duration of the aging process. Deformation caused by 10% elongation and aging at 250°C for 2 hr resulted in the precipitation of the nitride phase in a steel containing 0.035% nitrogen. The impurities tended to precipitate near the dislocation line. Only a small portion of the atoms, which may precipitate, remained in the deformed metal; therefore even prolonged soaking at elevated temperatures did not result in the usual dissociation pattern. (TTT)

13406 SOME PROPERTIES OF SCANDIUM METAL. P. G. Mardon, J. L. Nichols, J. H. Pearce, and D. M. Poole (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 189: 566-8(Feb. 18, 1961).

Scandium was used in an investigation of the alloying behavior of plutonium with metals of Group III. Studies were made to determine the properties of scandium. Results are reported from thermal analysis, electrical resistance, and x-ray diffraction studies of the behavior of the metal between room temperature and its melting point. (C.H.)

13407 BRITTLE FRACTURE AND REACTOR PRESSURE CIRCUITS. R. B. Kehoe and R. W. Nichols (United Kingdom Atomic Energy Authority, Reactor Technology Labs., Culcheth, Eng.). Nuclear Eng., 6: No. 58, 112-16 (Mar. 1961).

A review of the conditions under which brittle fracture could occur in a reactor pressure circuit is presented. It was concluded that the initiation and subsequent propagation of a brittle fracture in a reactor pressure vessel is a possibility so long as the steel is at a temperature at which it can behave in a brittle manner. The only means of obtaining absolute safety is by maintaining the vessel above the temperature below which brittle cracks can be propagated so that only ductile cracks are physically possible. The various tests designed to measure the temperature dependence of fracture behavior are discussed. Neutron irradiation of a steel was found to cause its transition temperature to rise. The relationship between embrittlement and neutron dose depends on specimen temperature during irradiation, dose rate, and neutron energy. (M.C.G.)

13408 ON THE METASTABLE γ-PHASE URANIUM–MOLYBDENUM ALLOYS. F. J. Blatt (Clarendon Lab., Oxford). Phys. and Chem. Solids, 17: 177-87(Jan. 1961). (In English)

The experimental data on metastable γ-phase uranium–molybdenum alloys of Chandrasekhar and Hulm (resistivity), of Berlincourt (Hall effect), and of Goodman et al. (specific heat) are examined within the framework of the band model suggested by Friedel. It is shown that all available data are consistent with a reasonable density of states curve, and the qualitative features of that curve are in agreement with those deduced by Friedel from the properties of pure uranium. Attention is directed to the thermoelectric power of these alloys as a means of further defining the band structure. (auth)

13409 CRITICAL MAGNETIC SCATTERING OF NEUTRONS IN MAGNETITE. T. Riste (Institutt for Atomenergi, Kjeller, Norway). Phys. and Chem. Solids, 17: 308-17(Jan. 1961). (In English)

The angular distribution of neutrons inelastically scattered from magnetite is analyzed for temperatures in the neighborhood of the Curie temperature. The breakdown of the spin-wave theory in this temperature region is discussed. Values of the parameters characterizing the critical fluctuations are deduced from the experiments and compared with theoretical predictions. Some quantitative aspects of the scattering indicate that kinematical braking of the fluctuations may exist. A tentative value of the diffusion constant Λ_1 is derived. (auth)

13410 NUCLEAR MAGNETIC RESONANCE IN FERROMAGNETIC Fe^{57}. A. C. Gossard, A. M. Portis, and W. J. Sandle (Univ. of California, Berkeley). Phys. and Chem. Solids, 17: 341-2(Jan. 1961). (In English)

The observation of a nuclear magnetic resonance in Fe^{57} is reported at temperatures of 77 and 295°K at frequencies of 46.54 and 45.49 Mc, respectively. (T.F.H.)

13411 GRAIN REFINEMENT OF URANIUM. J. Lehmann and H. Aubert. Rev. met., 55: 1188-94(1958). (CEA-1282). (In French)

A study was made on grain refinement of α uranium by

quenching from its β or γ phase. The effect of several alloying elements was discussed. To obtain a regular refinement, it is necessary to stabilize the β phase. The TTT (time–temperature–transformation) curves are then used. The TTT diagram has been determined on the basis of the alloy U–0.4 wt.% Al. (auth)

13412 INVESTIGATIONS OF RHENIUM–BERYLLIUM ALLOYS. V. N. Bulanov and I. N. Frantsevich. Voprosy Poroshkovoi Met. i Prochnosti Materialov, Akad. Nauk Ukr. S.S.R., 6: 32-5(1958). (In Russian)

An analysis of rhenium–beryllium microhardness showed a maximum hardness of 2221 kg/cm^2 in alloys containing 1 at.% (17.4 wt.%) rhenium. The rate of shrinkage in sintering, up to 66.7 at.% beryllium, was utilized in the physicochemical analysis. The limits of solubility were determined for alloys with 66.7 at.% beryllium at 1600°C and for cast alloys with high beryllium content. Peritectic transformations were found in the $ReBe_2$–Be system. (R.V.J.)

13413 ELASTIC CONSTANTS OF METAL CERAMIC MATERIALS. O. A. Chekhova and I. N. Frantsevich. Voprosy Proshkovoi Met. i Prochnosti Materialov, Akad. Nauk Ukr. S.S.R., 6: 36-41(1958). (In Russian)

The dependence of the elasticity modulus on porosity was studied in electrolytic and reduced iron and Permalloy with 78% nickel. With porosity above 10%, the elasticity modulus is reduced. The elasticity modulus for Permalloy in the ordered state is higher than that for the disordered state, indicating stronger interatomic bonds in the ordered state. (R.V.J.)

13414 WETTING HARD SURFACES OF HIGH-MELTING COMPOUNDS BY LIQUID METALS. Yu. V. Niadich and V. N. Eremenko. Voprosy Poroshkovoi Met. i Prochnosti Materialov, Akad. Nauk Ukr. S.S.R., 6: 53-64(1958). (In Russian)

The wetting of oxides increases with the increase of electroconductivity. The wetting of carbides is determined by s-d interaction. The wetting of borides by liquid copper was studied at 1100 to 1400°C and correlated with other properties. (R.V.J.)

13415 BORON NITRIDES. V. M. Steptsov and G. V. Samsonov. Voprosy Poroshkovoi Met. i Prochnosti Materialov, Akad. Nauk Ukr. S.S.R., 6: 65-79(1958). (In Russian)

The preparation, hydrostatic pressing, sintering, and physicochemical properties of boron nitrides are described. (42 references.) (R.V.J.)

13416 DEFORMATION AND RECRYSTALLIZATION IN (1 1 0)[0 0 1] SINGLE CRYSTALS OF IRON-SILICON ALLOY. Wang Wien-min, Chou Pang-hsin, and Chen Neng-kuan. Wu Li Hsüeh Pao, 16: 263-71(1960). (In Chinese)

Deformation and recrystallization in (1 1 0)[0 0 1] single crystals of iron-silicon (3.25%) with a reduction in thickness of 5 to 50% are described. In the range of a reduction of 2 to 16%, the slip planes are (1 0 1), (1 0 $\bar{1}$), (1 1 0), and ($\bar{1}$ 1 0), and the twinning planes are (1 1 2) and (1 1 $\bar{2}$). This coincided satisfactorily with explanations of the formation of cold-rolling textures in (1 1 0)[0 0 1] single crystals of iron-silicon alloys. It was observed that the position and growing process of recrystallized grains are different for cold-rolling and annealing treatments. The recrystallized grains from cold-rolling formed first at the twinning boundary and preferred growth there. But in annealing the crystals were formed by subgrains except at the twinning boundary and near the deformation bands, and the preferred growth was not as apparent as in cold-rolling. (auth)

13417 MAGNETIC COOLING WITH THORIUM–DYSPROSIUM ALLOYS. R. D. Parks and W. A. Little (Stanford Univ., Calif.). p.114-16 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

In a search for a paramagnetic alloy with sufficient spin entropy and low enough magnetic transition temperature to be used in a magnetic refrigerator, Th–Dy was studied. Data are given on magnetic susceptibilities and final temperatures reached by demagnetization from 0.73°K. (T.R.H.)

13418 ELECTRICAL RESISTIVITIES OF ZIRCONIUM WITH DILUTE ADDITIONS OF Ag, Cd, In, Sn, AND Sb. J. O. Betterton, Jr. and D. S. Easton (Oak Ridge National Lab., Tenn). p.270-3 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Electrical resistivities were measured and discussed for Zr and binary alloys of Zr with Ag, Cd, In, Sn, and Sb. The measurements were made at 4.2, 77.4, 194.7, 273.2, and 304.7°K. (T.R.H.)

13419 THE PRESSURE EFFECT IN SUPERCONDUCTING TANTALUM. C. A. Swenson and C. H. Hinrichs (Ames Lab., Ames, Iowa). p.345-7 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Because of disagreement in reported values, measurements were undertaken to determine directly the effect of pressure on the critical field curve of high-purity, highly degassed tantalum. The agreement of the magnetic data obtained with the zero field data is sufficient for the presumption that it is characteristic of high-purity tantalum. The reason for disagreement with results of others is not known. (T.R.H.)

13420 A STUDY OF THE BAND STRUCTURE AND SUPERCONDUCTING PROPERTIES OF SEVERAL γ-URANIUM ALLOYS FROM MEASUREMENTS OF THEIR SPECIFIC HEATS BETWEEN 1°K and 4°K. B. B. Goodman, J. Hillairet, J. J. Veyssie, and L. Weil (Université, Grenoble, France). p. 350-6 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

To further determine the shape of the density of states curve, the specific heats of a number of γ-uranium alloys were measured between 1 and 4°K. Such data are also of interest since the alloys become superconducting in the liquid helium range, and the results can be used to study the BCS relation for the transition temperature of a superconductor. The alloys studied contained 13.7, 17.8, 21.6, 25.3, and 29.6 at.% molybdenum and 25.9 at.% niobium. (T.R.H.)

13421 THE SPECIFIC HEATS OF SOME ZIRCONIUM ALLOYS. G. K. Kneip, Jr. and J. O. Betterton, Jr. (Oak Ridge National Lab., Tenn.). p.357-8 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The specific heats of dilute alloys of silver, indium, and tin in zirconium were measured at 1.2 to 4.5°K. Except for the two higher composition tin alloys that apparently undergo a superconducting transformation at about 1.25°K, the specific heats were found to consist of an electronic term plus a vibrational term and to obey the equation $C = \gamma T + \beta T^3$. (auth)

13422 SPECIFIC HEAT OF DYSPROSIUM METAL. J. G. Dash, R. D. Taylor, and P. P. Craig (Los Alamos Scientific Lab., N. Mex.). p.705-6 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The specific heat of dysprosium metal was measured between 0.25 and 2°K. The values for the metal, of normal isotopic composition, show an apparent hyperfine contribution below 0.5° and an anomaly of 0.028 R entropy between 0.5 and 2°K. The effective magnetic field at the nuclei is 6.4×10^6 gauss. (T.R.H.)

13423 REACTOR CORE MATERIALS. Quarterly Technical Progress Review, Vol. 3, No. 4. R. W. Dayton and E. M. Simons (Battelle Memorial Inst., Columbus, Ohio). Nov. 1960. 100p.

A review of the AEC Reactor Materials Handbook, 2nd edition, is presented. In research on fuel and fertile materials, uranium, α-phase uranium alloys, γ-phase uranium alloys, ϵ-phase alloys, dilute uranium alloys, plutonium alloys, thorium, dispersion fuels, refractory fuel, and irradiation effects in fuel materials were investigated. Development of beryllium metal and alloys and solid hydrides as reactor moderators is reported. An investigation was made of rare-earth oxides and boron control materials as nuclear poisons. Corrosion, metal-water reactions, radiation effects, mechanical properties, and metallurgy of cladding and structural materials were studied. Special fabrication techniques including melting, casting, heat-treatment, hot working, cladding, explosive forming, welding, and brazing are described. (M.C.G.)

Radiation Effects

13424 (ANL-5639) EFFECTS OF IRRADIATION ON THE EBWR FUEL ALLOY URANIUM-5 w/o ZIRCONIUM-1.5 w/o NIOBIUM. Final Report—Metallurgy Program 6.1.20. J. H. Kittel (Argonne National Lab., Ill.). July 1960. Contract W-31-109-eng-38. 43p.

Irradiations were made on small specimens of U—5 wt.% Zr—1.5 wt.% Nb alloy with a wide variety of fabrication histories and heat treatments in order to determine the optimum heat treatment for the fuel plates for the Experimental Boiling Water Reactor (EBWR). In the time available, a heat treatment could not be found which simultaneously conferred dimensional stability and corrosion resistance to the alloy. The most effective heat treatment for dimensionally stabilizing swaged or round-rolled material was a 24-hr isothermal transformation from the γ phase at 650°C. This heat treatment was subsequently used as a basis for the heat-treatment specifications for the EBWR fuel plates. In later studies on specimens cut from plates it was learned that the alloy could be adequately stabilized against irradiation growth and also made corrosion-resistant by first reducing the plate 12% in thickness by cold rolling followed by a 24-hr isothermal transformation from the γ phase at 665°C, and finally quenching from 800°C. Irradiation growth rates of plate specimens were effectively reduced by the presence of metallurgically bonded Zircaloy-2 cladding. Flat-rolled material under irradiation generally increased in length and width and decreased in thickness. (auth)

13425 (APEX-584) COMPATIBILITY OF MAGNET WIRES IN POTTING COMPOUNDS UNDER GAMMA IRRADIATION. S. F. Hemmenway and J. W. Kruetzkamp (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Mar. 1961. 50p. Contracts AF33(600)-38062 and AT(11-1)-171.

A method for determining the effect of γ radiation on potted magnet wire is described. Various types of insulations and potting compounds were tested to determine their suitability for use in temperature and γ-radiation environments. (auth)

13426 (CF-60-7-11) FISSION-GAS-RELEASE FROM UO_2, INTERIM REPORT NO. 1. J. G. Morgan, M. T. Morgan, and M. F. Osborne (Oak Ridge National Lab., Tenn.). Aug. 16, 1960. 17p. Contract W-7405-eng-26.

The evolution of fission products from UO_2 during irradiation at high temperatures is of primary interest to the Gas-cooled Reactor Project. Fuel tests consisting of UO_2 pellets encapsulated in Inconel or stainless steel were irradiated in the LITR, ORR, and ETR. The capsules were pierced in hot cells, and the gases collected in evacuated systems. Fractions of this gas, of suitable activity for counting, were taken and then analyzed by γ spectrometry. Larger fractions of gas were analyzed by mass spectrometry. Percentage of gas release varied widely, increasing with temperature, impurity content, oxygen-to-uranium ratio of the UO_2, and decreasing with bulk density. For high density, stoichiometric UO_2, the gas release was generally less than 3% up to a temperature of about 2800°F, about which it was greatly accelerated. Fuel burn-ups of up to 22,000 Mwd/MT were obtained. Maximum measured central fuel temperatures of 3150°F were reached. The lower-density nonstoichiometric UO_2 released greater amounts of fission gas, particularly Kr^{85}. (auth)

13427 (GA-P-32-257) Xe^{133} RELEASE DATA OBTAINED TO DATE ON VARIOUS SAMPLE FUEL BODIES. L. R. Zumwalt and E. E. Anderson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 15, 1960. Contract AT(04-3)-314. 9p.

Data on Xe^{133} release are presented for various irradiated fuel bodies. Included are xenon release curves on samples prepared by impregnating graphite with aqueous (normal) uranyl nitrate, followed by a drying and baking procedure, and those prepared by extrusion of compacts containing a mixture of UO_2 particles, graphite flour, and a resin binder. Component fractions and characteristic diffusion times are shown. (J.R.D.)

13428 (KAPL-2103) RADIATION EFFECTS UPON AND THE RECOVERY OF THE MECHANICAL PROPERTIES OF METALS. E. N. Aqua and R. J. Allio (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 25, 1960. Contract W-31-109-Eng-52. 27p.

The experimental data on the production and recovery of irradiation-induced mechanical-property change in metals are reviewed. Damage is interpreted as a two-stage process involving source and lattice hardening caused by clustered interstitials or vacancy clusters. Annealing entails migration of polyvacancies or dissipation of vacancy clusters and requires the activation energy of self-diffusion. A recovery parameter (Q/T) is defined. 76 references. (auth)

13429 (KAPL-M-MXB-5) ANALYSIS OF DATA OBTAINED ON PbTe N-TYPE SAMPLE WHILE UNDER ETR, FULL POWER, RADIATION. M. Balicki (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 29, 1960. Contract W-31-109-Eng-52. 41p.

In the course of experiments on the irradiation of instrumented thermoelectric materials in the Engineering Test Reactor, erratic behavior of one of the temperature indications from the PbTe specimen was observed. The electric potentials of various sample points were measured, and the

possibility of miswiring was checked. The results indicate that the temperature was in reality higher than indicated by the thermocouple and that the discrepancy was due to short circuiting of the thermocouple. (D.L.C.)

13430 (NP-9874) MONTHLY ACCESSION LIST 44 [ON RADIATION EFFECTS DATA]. JANUARY 1 THROUGH JANUARY 31, 1961. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Feb. 15, 1961. Contract AF33(616)-7375. 21p.

A total of 67 references with appended abstracts is presented on radiation effects, in addition to reports and memoranda. The following topics are included: electrical and electronic systems, polymers, lubricants, organic chemicals, ceramic materials, metals, alloys, dosimetry, facilities, and space radiation. (D.L.C.)

13431 (NYO-2690) NUCLEAR FUEL RESEARCH FUEL CYCLE DEVELOPMENT PROGRAM. Quarterly Progress Report, July 1 to September 30, 1960. (Olin Mathieson Chemical Corp., Baltimore). Nov. 11, 1960. Contract AT(30-1)-2374. 42p.

Work was continued on the development of a UO_3 pellet fabrication process based on low-temperature sintering in an inert atmosphere. A study of the chemical and physical characteristics of several ADU oxides was carried out to determine the cause of poor sinterability. The properties investigated included (1) particle-size distribution, (2) surface area, (3) microscopic appearance, (4) hydrogen sinterability, and (5) chemical analysis. No clear distinguishing difference among the various oxides lots was found, which accounts for the observed variation in sinterability. A program aimed at improving sinterability by activation techniques was initiated. Oxidation-reduction cycling was the most effective. After one cycle, consisting of oxidation to U_3O_8 at 500°C and reduction to UO_2 at 525°C, all production lot oxides could be densified to at least 95% of theoretical at temperatures not exceeding 1300°C. The enhancement of sinterability is so pronounced that such densities were achieved after sintering at as low as 1100°C for only 1 hr in nitrogen. High-temperature hydrogen sinterability was similarly improved. Chemical analyses of uranium carbide prepared by the methane reaction indicated that improvements are necessary in the control of heating rate and time at temperature for the carburizing step to achieve adequate carbon compositional control. The analyses indicated the uranium carbide product was not affected by increasing the carburizing gas flow rate in the retort. Using methane, it appears that the average of nitrogen, oxygen, and free carbon contents are 0.43, 0.77, and 0.25%, respectively. A preliminary study was made of the use of propane for carburizing uranium. The results indicated that the free carbon was slightly higher than that obtained with methane, but that the nitrogen and oxygen contents were significantly lower, viz., 0.06% nitrogen and 0.22% oxygen. Work on the cold pressing and 1800°C vacuum sintering of uranium carbide produced by the methane reaction indicated that the best densities that could be achieved by this method with essentially stoichiometric uranium monocarbide were 11.2 to 12.2 g/cm^3. Nitrogen and oxygen appear to form an isomorphous solid solution in the uranium monocarbide structure and do not appear to enhance the sinterability. It was found that the presence of free uranium is essential and that approximately 51 at.% or more of uranium must be present in the composition to achieve a high sintered density. Densities approaching the theoretical were obtained when an adequate quantity of free uranium was present, either because of the composition of the product as produced from the methane-uranium reaction or when adjusted in composition by the addition of uranium in the form of uranium hydride to the powder mixture prior to cold pressing and sintering. Improvements were made in the skull arc-melting and casting technique by utilizing a ten-turn water-cooled coil inserted beneath the crucible in the skull furnace. This provided sufficient magnetic field at 400 amp to prevent arc deflection during melting uranium carbide at 2500-amp melting current. Pelletized uranium oxide-graphite charge materials were reacted and melted in the arc furnace which yielded a uranium monocarbide product containing 4.71% carbon, 0.084% oxygen, and 0.06% nitrogen. Work was carried out on the use of pre-reacted uranium oxide graphite mixtures to form a consumable electrode. An electrode, pre-reacted by vacuum-induction heating at 2000°C, was consumably arc-melted successfully. (auth)

13432 (TID-11556) IN-PILE IRRADIATION EFFECTS ON SEMICONDUCTOR SWITCHES. Milestone Summary Report, Task 51140-2. S. F. Hemmenway (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Nov. 30, 1960. Contracts AF33(600)-38062 and AT(11-1)-171. 29p. (XDC-60-12-123)

The test circuitry for the irradiation testing of gallium arsenide tunnel diodes and GE C35 silicon-controlled rectifiers is shown. The test circuitry and the results of an irradiation test of silicon and germanium tunnel diodes are given. The silicon tunnel diodes were still usable (peak-to-valley ratio of 2) at 10^{16} nvt fast neutrons. The germanium tunnel diodes were still useful (peak-to-valley ratio of 2) at 10^{17} nvt. Both were tested at reactor ambient temperature. (auth)

13433 (TID-11877) THE NATURE OF IRRADIATION DAMAGE IN THE NOBLE METALS. Technical Report No. 23. J. S. Koehler (Illinois. Univ., Urbana). Feb. 1961. Contract AT(11-1)-182. 24p.

The nature of irradiation damage in the noble metals is described. The sizes of the clusters of interstitials and vacancies produced by 1.4-Mev electrons, 9-Mev deuterons, and pile irradiation are compared. Arguments are given for the possibility that thermal spikes produce important annealing effects in deuteron and pile damage. The ability of thermal spikes to produce disorder in an ordered alloy is described. (auth)

13434 (TID-11922) BASIC RADIATION DAMAGE STUDIES. (Purdue Univ., Lafayette, Ind.). Apr. 1, 1958. Contract AT(11-1)-125. 64p.

Studies of electron bombardment of germanium and silicon near the threshold of bulk damage were made. For germanium the plot of conductivity vs. electron dose showed a rise to a maximum and then a linear decrease. The energy dependence of the derivative of the carrier density with respect to electron flux was determined. The results are interpreted in terms of a surface effect; the surface treatment was found to have a marked effect on the behavior under low-energy irradiation. The radiation effects on the photoconductivity and surface conductance of n- and p-type germanium were studied. A model of the germanium surface is proposed. The effects of high-energy radiation on the photoconductivity were studied and interpreted in terms of bands and defect levels. On the basis of electron irradiation studies of silicon at 4.5 Mev and lower energies, it is concluded that some deep-lying levels in silicon depend on heat treatment, surface behavior, and current intensity. (D.L.C.)

13435 (VDIT-29) THE INVESTIGATION OF RADIATION EFFECTS IN SOLIDS BY MAGNETIC RESONANCE.

A Literature Survey. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). Feb. 1961. 16p.

A general survey of work being done on magnetic resonance in irradiated solids is given. Electron spin and nuclear magnetic resonance are treated. Abstracts are included for most of the 47 references given. (D.L.C.)

13436 (WADD-TR-60-645) RADIATION EFFECTS ON ELECTRONIC COMPONENTS: A COMPARISON OF PAPER CAPACITORS IMPREGNATED WITH VITAMIN "Q" MINERAL OIL AND BIS-(P-PHENOXYPHENYL) ETHER. Milton E. L. Zellmer (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio) and Dennis R. Johnson (Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio). Nov. 1960. Project No. 7360. 38p.

Bis-(p-phenoxyphenyl) ether (BPPE) proved to be highly resistant to irradiation damage. Paper capacitors impregnated with BPPE and others impregnated with vitamin "Q" were irradiated for comparison. Tests with both failed. The paper itself was the major contributor of gassing and the subsequent cause of catastrophic breakdown and even rupture of the capacitor casings. Therefore, until some nongassing dielectric material is found, BPPE, though having a low rate of radiation-induced gassing, will not solve the lightweight radiation-resistant capacitor problem. (auth)

13437 (NP-tr-574) THE EFFECT OF IRRADIATION ON THE STRUCTURE AND PROPERTIES OF STRUCTURAL METALS. S. T. Kishkin. Translated from a publication of the State Publishing House of the Defense Industry, Moscow, 1958. 91p.

Radiation effects on the properties of metals and alloys are treated on the basis of Frenkel defects. Experimental data are reviewed from the point of view of the general theory of alloying and reenforcing of alloys. An irradiated metal containing Frenkel defects is considered as a very metastable solid solution of the interstitial type. For metals with self-diffusion activation energy of >92 kcal/mole, the formation of melted zones due to irradiation is excluded; however, for energies >92 kcal/mole, melting becomes a probable process. (D.L.C.)

13438 (SCL-T-349) EXCERPTS FROM RECOMBINATION CENTERS CREATED IN GERMANIUM BY FAST NEUTRONS. Nguyen van Dong and A. Barraud. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from J. Electronics and Control, 7: 285-8(July/December 1959). Nov. 22, 1960. 4p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 12063.

13439 GAMMA RADIATION EFFECTS ON DIELECTRIC PROPERTIES OF CERTAIN INSULATING MATERIAL. I. TEXTOLITE GLASS SKM-1. K. A. Vodop'yanov and B. I. Vorozhtsov (Siberian Inst. of Physics and Tech., Kuibyshev Tomsk State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 227-32(1960). (In Russian)

The influence of γ radiation on the dielectric properties of Textolite glass, SKM-1, was investigated. The results indicated that under certain conditions (low temperature, tropical humidity, etc.) the dielectric properties of Textolite glass change. The changes vary with radiation dosage. (tr-auth)

13440 DIELECTRIC LOSSES IN X-RAYED NaCl, KCl, AND KBr CRYSTALS STUDIED AT ELEVATED TEMPERATURES AND AT A WAVELENGTH OF 3.18 cm. I. I. Ezhik and S. T. Shavlo (Skovoroda Kharkov Inst.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 5, 13-20(1960). (In Russian)

Dielectric losses in x-rayed alkali halide crystals were determined at 290 to 600°K. The dielectric loss maximums for NaCl are at 350, 410, and 490°K; for KCl at 320 and 390°K; and for KBr at 350°K. A relation was found between the observed tg δ maximums and the maximums for infrared and ultraviolet luminescence and between photoconductivity and temperature. The maximum tg δ as a function of temperature is described by a kinetical scheme. (tr-auth)

13441 EFFECTS OF γ RADIATION ON THE DIELECTRIC PROPERTIES OF INSULATION MATERIALS. V. SILICOORGANIC RESIN TYPE MATERIALS. K. A. Vodop'yanov and B. I. Vorozhtsov (Siberian Inst. of Physics and Tech., Tomsk State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 5, 118-23(1960). (In Russian)

The effects of γ radiation on the dielectric properties of silico-organic resins (polydimethyl siloxane elastomers with titanium dioxide, silica gel, zinc white, and red oxide) were studied. It was found that dielectric variations are caused by changes in current carriers and by structural transformations. (R.V.J.)

13442 AN ESTIMATE OF THE EFFECT OF RADIATION ON THE THERMAL CONDUCTIVITY OF BERYLLIUM. G. J. Dienes and A. C. Damask (Los Alamos Scientific Lab., N. Mex.). J. Nuclear Materials, 3: 16-20 (Jan. 1961). (In English)

The thermal conductivity and electrical resistivity of beryllium at low temperatures are analyzed. From existing data on the effect of reactor irradiation on the electrical resistivity of beryllium, the effect of reactor irradiation at low temperatures on the thermal conductivity is predicted. The arguments show that a reactor exposure of 10^{19} nvt (fast) should decrease the thermal conductivity of beryllium by approximately 0.04 watt/cm/°K at temperatures of 20 to 30°K. This is measurable but is probably unimportant in practice. High- and low-purity beryllium should be affected similarly. Warming the beryllium to 250°K should cause rapid and complete annealing of the radiation-induced change of thermal conductivity. (auth)

13443 IRRADIATION GROWTH OF ZIRCONIUM–PLUTONIUM ALLOYS. J. A. Horak and H. V. Rhude (Argonne National Lab., Ill.). J. Nuclear Materials, 3: 111-12(Jan. 1961). (In English)

Four cold-worked zirconium–plutonium rods 0.40 cm in diameter and containing 5 or 7 wt.% plutonium were irradiated in the Materials Testing Reactor to total burn-up 0.8 to 1.8%. Initial irradiation temperatures were near 500°C, and the reactor was shut down 73 times during the irradiations, producing a thermal-cycling effect. The rods grew during irradiation to two to four times their original lengths, and the cross section decreased in area and became trapezoidal. The density decreased by ~3%. This anisotropic growth indicates that the cold forging and rolling used to prepare the rods produced a high degree of preferred orientation. (D.L.C.)

13444 RADIATION, MOISTURE, AND TEMPERATURE EFFECTS IN FILLED EPOXY REPLICA FLAT MIRRORS. D. E. Kline and J. H. Saxton (HRB-Singer Research Labs., State College, Penna.). J. Opt. Soc. Am., 51: 447-51(Apr. 1961).

The effects of nuclear radiation, moisture absorption, and temperature history on replica flat mirrors of filled epoxy were investigated using the optical flat testing method. A radiation dose of the order of 10^{10} ergs/g is required to produce changes in surface flatness. Residual activity after neutron irradiation is found to be somewhat less than that of Pyrex glass. Absorption of a fractional

percentage of water causes a loss of flatness, but flatness can be restored by removing the moisture with elevated temperature baking. Flats appear to survive temperature cycling from −200 to +125°C with little detectable changes. When the mirrors are being subjected to temperatures above 140°C, the flatness decreases, and the reflecting surface deteriorates rapidly. (auth)

13445 CHANGES OF THE MECHANICAL AND PHYSICAL PROPERTIES OF CARBONACEOUS IRON ALLOYS EXPOSED TO NUCLEAR RADIATION. I. M. Pronman (Metallurgical Inst., Academy of Sciences, USSR). Metalloved. i Termicheskaya Obrabotka Metal., No. 1, 36-47 (Jan. 1961). (In Russian)

Nuclear radiations exert an effect on metals by disturbing the normal crystal structure as high-energy particles such as protons, deuterons, α particles, fission fragments, or electrons and create Frenkel defects. Armco-iron and steels irradiated with a high integrated neutron flux presented increased hardness—the iron and the soft steels exhibited this effect to a greater extent than originally hard steels; similarly the effect was more enhanced on heat-treated than on cold-worked steels. The yield strength of the steels was also increased by exposure to neutron radiation; whereas plasticity and specific elongation were decreased. The resilience of high-grade alloys was less affected than that of impure, phosphorus and sulfur containing steels. The beneficial effect of the radiation increased with the flux up to an integrated flux of about 10^{19} to 10^{20} neutrons/cm^2. The specific resistivity changed only slightly. Phase transformation was caused in some metals such as tin; the alloy containing the uranium + 9% molybdenum (α uranium + γ' phase) was transformed into the homogeneous γ phase consisting of a solid solution of molybdenum in uranium, presenting an effect similar to that of heat treatment. (TTT)

13446 CONTROL OF IRRADIATION EMBRITTLEMENT IN MOLYBDENUM. D. N. Sethna, A. A. Johnson, K. J. Proud, and S. S. Sheinin (Imperial Coll. of Science and Tech., London). Nature, 189: 568(Feb. 18, 1961).

Experiments were performed on molybdenum with two different types of dislocation structures to observe the expected dependence of irradiation embrittlement on dislocation density and distribution. The first type was heavily cold-worked by swaging and the second type heavily cold-worked and then stress-relieved at 1,000°C for 0.5 hr to give a fine substructure. The starting material in each case was Murex sintered molybdenum containing nominally 50 to 100 ppm carbon, 50 ppm iron, 20 ppm oxygen, 10 ppm hydrogen, and 5 ppm nitrogen. Both materials were machined into Hounsfield type tensile specimens, and four batches of ten specimens of each were irradiated in Bepo for 3, 6, 9, and 12 months, respectively, at a temperature of 40 to 50°C. The corresponding integrated epithermal neutron fluxes were about 1, 2, 3, and 4×10^{19} nvt. The ductile-brittle transition temperatures of the unirradiated materials and of each of these eight batches of irradiated specimens were measured using a modified Hounsfield tensometer operating at a strain rate of 0.88×10^{-4} sec.$^{-1}$. Results indicate that at least some measure of control of the irradiation embrittlement of body-centered cubic transition metals can be achieved by using materials with controlled dislocation structures. (C.H.)

13447 THE EFFECTS OF GAMMA RADIATION ON SOLIDS. EXO-ELECTRON EMISSION FROM IRRADIATED IRON OXIDE CATALYSTS. E. J. Gibson (Warren Spring Lab., Stevenage, Herts, Eng.). Phys. and Chem. Solids, 17: 220-8(Jan. 1961). (In English)

The results are presented of an exploratory study into the emission of exo-electrons from powdered iron oxide catalysts for the Fischer–Tropsch synthesis after exposure to gamma radiation. It is considered that the evidence supports the theory that emission centers consist of oxygen-ion vacancies containing trapped electrons. Irradiation appears to fill the vacancies with electrons. (auth)

13448 PROPERTIES OF LITHIUM HYDRIDE—II OPTICAL ABSORPTION BY COLOR CENTERS. F. E. Pretzel (Los Alamos Scientific Lab., N. Mex.) and C. C. Rushing. Phys. and Chem. Solids, 17: 232-45(Jan. 1961). (In English)

The optical properties of color centers involving trapped electrons in LiH show that properties of the crystalline media other than the lattice parameter are important in relation to the energy of the optical absorption bands. The F band in LiH is found at 2.4 ev instead of at 4.8 ev, as predicted by the Ivey formula for F bands in the alkali halides. Other properties of the F band in LiH are consistent with expectations from the F-center model and with the high vibrational frequency and high cation-vacancy mobility in LiH crystals. The M band, lithium-colloid band, and other bands in LiH are also shifted to lower energy; therefore the sequence of bands in LiH is comparable to the familiar sequence found in KCl. The principal V band in LiH is at 3.5 ev. The properties of the center responsible for the V band are consistent with those of an H_2 molecule trapped at an anion site. This is the same as one proposed for the V_1 center in KCl. "Impurity" bands are found both in "pure" and in magnesium-doped LiH crystals. Bands due to magnesium colloid and Z type centers are found, along with a series of fine-structure lines like those previously reported only in LiF. (auth)

13449 IONIZATION OF LITHIUM BY FAST PROTONS AND ELECTRONS. M. R. C. McDowell (Georgia Inst. of Tech., Atlanta) and G. Peach. Phys. Rev., 121: 1383-7 (Mar. 1, 1961).

Born's approximation is used to calculate the cross sections for ionization of lithium by fast protons (< 1 Mev) and electrons (< 1 kev). The maximum cross section for proton impact is $1.1\pi a_0^2$ at 20 kev. (auth)

13450 THE USE OF SUPERCONDUCTIVITY IN STUDYING NEUTRON IRRADIATION DAMAGE IN RHENIUM AND TIN. J. Blanc, B. B. Goodman, G. Kuhn, E. A. Lynton, and L. Weill (Institut Fourier, Grenoble, France). p.393-5 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A study is reported on the effects of neutrons on superconductors in which specimens were irradiated at room temperature and at 77°K in a swimming-pool reactor and then annealed at various temperatures. From magnetization curves the critical temperature T_c and the frozen-in moment, m, are deduced. For rhenium, m increases appreciably though less rapidly than proportionally to the neutron dose, and T_c increases also. Tin showed initial increases in m that varied more slowly than dose, but they were 5 to 10 times smaller than for rhenium. T_c was lower by 10 to 30 millidegrees. (T.R.H.)

13451 IRRADIATION EFFECT ON THE TRANSITION TEMPERATURE OF SUPERCONDUCTING TIN. L. Rinderer (Université, Lausanne, Switzerland) and E. Schmid. p.395-6 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A 0.5 × 0.02 × 10 mm tin strip was irradiated at He tem-

peratures on both sides by a 50 mc polonium α source at a distance of 0.5 mm. The residual resistivity ratio vs. irradiation time is shown. The Frenkel pairs are homogeneously distributed. An enormous decrease in transition temperature with irradiation time, 50 times greater than in alloyed tin with the same amount of imperfection, was evident. The effect disappeared after annealing for 24 hr at room temperature. (T.R.H.)

PHYSICS

General and Miscellaneous

13452 (58-RL-1965) THERMAL STRESSES IN A HEAT-GENERATING CYLINDER: THE VARIATIONAL SOLUTION OF A BOUNDARY LAYER PROBLEM IN THREE-DIMENSIONAL ELASTICITY. G. Horvay, I. Giaever, and J. A. Mirabal (General Electric Co. Research Lab., Schenectady, N. Y.). July 1958. 32p.

The effect (mode of stress penetration and extinction) of self-equilibrated loads applied to the end-faces of cylinders was studied. The solution is of interest in analyzing the elastic behavior of punches and in evaluating the thermal-stress behavior of cylindrical fuel elements. The mathematical method developed (the variational method, using orthogonal boundary polynomials in cylindrical coordinates) is seen to be of broad applicability in stress analysis and is not confined to the present problem. (auth)

13453 (AFBMD-TR-60-184) ABSOLUTE INTENSITY OF NON-EQUILIBRIUM RADIATION IN AIR AND STAGNATION HEATING AT HIGH ALTITUDES. Research Report 93. J. C. Camm, B. Kivel, R. L. Taylor, and J. D. Teare (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Dec. 1959. Contracts AF 04(647)-278 and DA-19-020-ORD-4862. 37p.

An attempt to obtain the magnitude of the nonequilibrium radiation behind a normal shock in air is reported. It is noted that the high nonequilibrium temperatures force an extension of studies farther into the ultraviolet and infrared regions than is required for equilibrium predictions of significant sources of radiation, e.g., to ascertain that the total nonequilibrium radiation is less than 1 w/cm^2 requires measurements from several hundred angstroms to more than 10 μ. Measurements covering much of this region with monochromator and photocells, bolometers, photoelectric detectors, spectrographs, and infrared photocells are reported. At 23,000 ft/sec, the radiation integral normal to the shock is about 0.4 $watt/cm^2$ steradian, and most of the radiation originates within 5 cm of the shock front. Calculations are reported which show that the effect of ambient atomic oxygen at high altitudes does not introduce any pronounced changes. Application of the results to the problems of satellite heating is made. (auth)

13454 (AFOSR-202) IONIZATION YIELD OF LOW-ENERGY HEAVY IONS IN ARGON. Final Report. J. A. Phipps, R. A. Lowry, and J. W. Boring (Virginia. Univ., Charlottesville. Research Labs. for Engineering Sciences). Feb. 1961. Contract AF-49(638)-22. 33p. (EP-4419-106-61U)

A cylindrical ionization chamber with a differentially pumped open window was used to measure the total ionization yield of low-energy heavy ions stopped in argon gas. Measurements were made at 8 to 100 kev for hydrogen, helium, carbon, nitrogen, oxygen, and argon ions. The average energy loss per ion pair ranges from 26.8 ev for 50-kev hydrogen ions to 91.8 ev for 25-kev argon ions. A comparison of the ionization yields in argon by various ions having velocities in the same region is presented. (auth)

13455 (AFOSR-306) RADIO EMISSION BY PLASMA OSCILLATIONS IN NONUNIFORM PLASMAS. D. A. Tidman and George H. Weiss (Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Feb. 1961. Contracts AF04(647)-309 and AF18(600)-1315. 30p. (BN-230)

A calculation is presented of the electromagnetic radiation emitted when a field of longitudinal plasma oscillation is incident on a localized fluctuation in density. Use is made of the collisionless Boltzmann equation to describe the electron component of the plasma and to compare the results with those previously obtained using the moment equations. (W.L.H.)

13456 (AFOSR-TN-60-1353) THE ROLE OF CRYSTAL STRUCTURE-IN DIFFUSION. PART I. DIFFUSION PATHS IN CLOSEST-PACKED CRYSTALS. Leonid V. Azaroff (Illinois Inst. of Tech., Chicago). Dec. 1, 1960. Contract AF49(638)-425. 21p.

A study of the crystal structures of simple binary compounds shows that they can be represented by closest packings of the larger anions in which two kinds of interstices are available for occupation by the metal atoms. In hexagonal closest packings, the octahedral voids form continuous chains by sharing opposite faces while the tetrahedral voids form isolated pairs. In cubic closest packings, each kind of void shares faces only with unlike voids. The specific diffusion paths available in these compounds depend, therefore, on the manner in which the voids are occupied. Continuous diffusion paths comprising normally unoccupied voids exist in ZnO and α-ZnS type structures so that voidal diffusion can take place without requiring defect formation. Similarly, voidal diffusion can occur in BiO_3, $CrCl_3$, and CdI_2 type structures. Conversely, all possible continuous diffusion paths are blocked by metal atoms in the NiAs, NaCl, and anti-fluorite type structures so that vacancy or interstitialcy mechanisms are necessary to account for diffusion. (auth)

13457 (CAL-SA-987-S-6) LINEAR THERMODYNAMICS AND THE MECHANICS OF SOLIDS. M. A. Biot (Cornell Aeronautical Lab., Inc., Buffalo). June 1958. 50p.

The thermodynamics of linear irreversible processes is presented from a unified viewpoint. This provides a new and synthetic approach to the linear mechanics of deformation of solids, which includes as particular cases the classical theory of elasticity, thermoelasticity, and viscoelasticity. The first two sections constitute an introduction to the general concepts and principles of linear thermodynamics as developed in the earlier work and presented in somewhat more detail. This is followed by the application of the general thermodynamic theory to thermoelasticity which combines the theories of elasticity, heat transfer, and their coupled effects into a single treatment. Some immediate consequences are derived such as the property of diffusion of entropy and certain fundamental relations with reference to thermal stresses. The introduction of inertia forces leads to a general formulation of thermoelastic dissipation of dynamical systems by Lagrangian methods. The second order heat produced by the dissipation is evaluated. Linear viscoelasticity and relaxation phenomena are also

a particular case of the thermodynamic theory. The resulting stress-strain relations with heredity properties are discussed. The operational formulation of these relations leads naturally to a formal correspondence with the theory of elasticity and to an operational-variational principle. The latter provides a generalization of Lagrange's equations in integro-differential form to the dynamics and stress analysis of viscoelastic structures. Some specific applications of these principles are presented. (auth)

13458 (HE-150-186) A COMPARISON BETWEEN LANGMUIR PROBE AND MICROWAVE ELECTRON DENSITY MEASUREMENTS IN AN ARC HEATED LOW DENSITY SUPERSONIC WIND TUNNEL. L. Talbot, J. E. Katz, and C. L. Brundin (California. Univ., Berkeley. Inst. of Engineering Research). Jan. 27, 1961. Contract AF49(638)-502. 33p.

Measurements were made of the electron density in a low-density supersonic plasma jet flow by the stagnation point Langmuir Probe method and by a microwave interferometric technique. The two methods yielded results in reasonably good agreement. It was possible to obtain some information on the radial distribution of ionization in the jet from the microwave measurements. An attempt to determine the electron temperature by measurement of the microwave power radiated from the jet was not successful. (auth)

13459 (HW-67219) NUCLEAR PHYSICS RESEARCH QUARTERLY REPORT, JULY, AUGUST, SEPTEMBER 1960. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 20, 1960. Contract AT(45-1)-1350. 114p.

Results are reported of the neutron-induced fission in low-energy resonances of Pu^{240} and of resonances in the target nuclides Pu^{242}, U^{236}, U^{238}, and Pa^{231}. A three-axis crystal spectrometer was constructed for the study of different inelastic scattering cross sections of neutrons in the energy range from near thermal to a few tenths of an ev. Results are reported of the scattering of 0.147-ev neutrons from water. Hanford's 2-Mev positive ion Van de Graaff accelerator was equipped with motor-driven supports, which permit mechanical positioning of the accelerator from a remote station in the control room. The electrode system installed to determine the location of the ion beam within the vacuum system is described. The system is designed to furnish information necessary for the positioning of the accelerator and further alignment of the beam. A study is reported of the position and energy dependence of the neutron flux in a heterogeneous system. The effect of a 1/v absorbing cylinder on the thermal flux in a surrounding nonabsorbing moderator is treated in an improved approximation. The basic improvement embodied in the solution is the use of a more accurate description of the energy dependence of the blackness of the absorber. A study was made on the interpretation of PCTR measurements of K_∞ for the case in which the addition of poison perturbs the neutron flux distribution in any or all of the various components of the test cell. Measurements were also made of K_∞ for lattices in which only one fuel element or one central cell is available. Lattice-cell flux traverses from experiments were examined in order to develop a method for calculating reaction rates in uranium-graphite heterogeneous systems. Variations in the neutron energy spectrum were examined to improve standard methods, especially for systems at elevated physical temperatures. The material buckling and extrapolation lengths were measured in three exponential piles. One pile was 6-ft wide and 8-ft long with a lattice spacing of $8^3/_8$ in. The second was 8-ft wide and 8-ft long with a lattice spacing of $8^3/_8$ in. The third pile was 10-ft wide and 8-ft long with a lattice spacing of $14^9/_{16}$ in. A tube-in-tube natural-uranium fuel element with water coolant was used in all three piles. Proposed studies for the critical facility of the Plutonium Recycle Program are reported. A series of exponential pile measurements were made to determine the criticality of 2.6% enriched uranium dioxide rods in light-water lattices. These measurements were made primarily to obtain data for establishing nuclear safety criteria relative to proposals for processing power reactor fuels. (For preceding period see HW-64866.) (W.L.H.)

13460 (JPL-TR-32-56) PLASMA THEORY OF ELECTRON-PHONON INTERACTION IN METALS. Oldwig von Roos (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Jan. 25, 1961. Contract NASw-6. 22p.

The recently developed transport theory of an electron gas is extended to include interaction with ions in a metal. The perturbation of lattice vibrations induced by an anisotropy of the electron distribution is calculated. Subsequently the ionic degrees of freedom are eliminated from the transport equation of the electrons in favor of a long-range electron-correlation term. The influence of this term becomes important at long wavelengths (in the far infrared) but constitutes a small perturbation for the eigenfrequencies of collective motion of the electron gas. Nevertheless, the dispersion relation for the collective oscillations shows that the contributions from the phonon interaction are of the same order of magnitude as the influence of thermal agitation. (auth)

13461 (LAMS-2517) TABULATED VALUES OF THERMAL DIFFUSION COLUMN SHAPE FACTORS FOR THE LENNARD-JONES (12-6) POTENTIAL. B. B. McInteer and M. J. Reisfeld (Los Alamos Scientific Lab., N. Mex.). Feb. 15, 1961. Contract W-7405-eng-36. 56p.

This report supersedes LAMS-2413.

Thermal diffusion column shape factors (h, k_c, and k_d), which are functions of the transport properties of gases, were evaluated for a gas with molecules that interact according to the Lennard-Jones (12-6) potential. The values are tabulated for reduced temperatures at the cold wall of the column (T_1^*) of 0.8 to 30. (B.O.G.)

13462 (LMSD-703087) THEORETICAL CALCULATIONS ON SPIN-WAVE RESONANCE IN THIN FILMS. Jerome I. Kaplan (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Aug. 1960. 33p.

A summary is presented of work done on the theoretical aspects of ferromagnetic resonance in thin films. The absorption in the range of linear effects is calculated for both perpendicular and parallel static magnetic fields; line broadening effects are included. The absorption for a sample with a step function in the anisotropy field is calculated and compared with some experimental results. Nonlinear effects are calculated for a nonconducting film with a perpendicular field. (D.L.C.)

13463 (MND-P-2309) SNAP I MERCURY BOILER DEVELOPMENT, JANUARY 1957 TO JUNE 1959. John Jicha and James J. Keenan (Martin Co. Nuclear Div., Baltimore). June 1960. 102p. Contract AT(30-3)-217.

The mercury-boiler development program was undertaken to develop a system that would utilize the heat of radioisotope decay to boil and superheat mercury vapor for use with a small turbine-generator package. Through the use of a Rankine cycle, the mercury vapor can be provided continuously to power a turbine-driven alternator and produce electricity for extended periods of time. This mercury

boiler and the related power-conversion system was planned for a satellite that would orbit the earth. This system design and development program was designated as SNAP-I. Development of the mercury boiler is described and a chronological description of the various mercury-boiler concepts is presented. The applicable results of an extensive literature survey of mercury are included. The mercury-boiler experimental-test-program description provides complete coverage of each experimental boiler and its relation to the system design of that period. A summary of all mercury boilers and their final disposition is also given. (auth)

13464 (NP-9714) LITERATURE AND INDUSTRIAL SURVEY AND OUTLINE OF EXPERIMENTAL TEST PROGRAM FOR DEVELOPMENT OF ION PROPELLANT SYSTEM. Interim Report No. 1. P. J. Lawler and M. W. Mueller (Thompson Ramo Wooldridge, Inc., Cleveland). Aug. 26, 1960. Contract AF33(616)-7219. 59p. (ER-4155)

A report comprising a literature and industrial survey on ion propellant systems and a comprehensive outline of the experimental test program and problems to be investigated is presented. The object of the one-year program, which began Mar. 15, 1960, is to construct, test, and deliver a complete prototype propellant system one year from initiation of program. A major portion of the program is directed toward the design and testing of component and system hardware. The results of the literature and industrial survey on ion engine development and cesium metal are included. Operation and theory of ion engines are reviewed. 59 references. (auth)

13465 (NP-9756(Pt. II)) PHYSICS OF THE IONIZATION PROCESSES IN AIR. PART II. DISSOCIATION AND RECOMBINATION OF IONS. An Annotated Bibliography. George R. Evans, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Dec. 1960. 37p. (SB-60-40(Pt. II)).

An annotated bibliography consisting of 76 references to works published during 1950 to 1960 is presented on the dissociation and recombination of ions and electrons. (B.O.G.)

13466 (NP-9756(Pt. III)) PHYSICS OF THE IONIZATION PROCESSES IN AIR. PART III. ELECTRON THEORY. An Annotated Bibliography. George R. Evans, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Dec. 1960. 31p. (SB-60-40(Pt. III)).

An annotated bibliography consisting of 66 references to works published during 1950 to 1960 is presented. The topics covered are affinity, atomic reactions, attachment, capture, collision, density, detachment, diffraction, diffusion, emission, energy expenditure per ion for electrons, excitation, loss, and mobility. (B.O.G.)

13467 (NP-9756(Pt. IV)) PHYSICS OF THE IONIZATION PROCESSES IN AIR. PART IV. (OTHER) SECONDARY PROCESSES OF IONIZATION. An Annotated Bibliography. George R. Evans, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Dec. 1960. 56p. (SB-60-40(Pt. IV)).

An annotated bibliography consisting of 128 references to works published during 1950 to 1960 is presented on the physics of secondary ionization processes. The processes considered deal with gaseous argon, hydrogen, nitrogen, and oxygen ions; diffusion, density, and mobility of ions; ion-atom and ion-molecular reactions; and ionized media. (B.O.G.)

13468 (NP-9798) DEVELOPMENT OF AN ION PROPELLANT SYSTEM. Quarterly Technical Progress Report No. 2, June 15, 1960 to September 15, 1960. P. J. Lawlor and M. W. Mueller (Thompson Ramo Wooldridge Inc., Cleveland). Sept. 26, 1960. 27p. Contract AF33(616)-7219 Item II. (ER-4195).

Component development for an ion propellant system is described. For cesium storage a vapor-activated bellows tank was evaluated. A wetting porous-bed cesium vaporizer is being fabricated. In this connection wetting tests were performed on oxides of Al, Mg, Nb, Ta, and Zr. Auxiliary equipment development included a metering pump and a check valve. Dry-box handling of cesium is briefly discussed. (For preceding period see NP-9677.) (T.R.H.)

13469 (NP-9858) QUARTERLY PROGRESS REPORT NO. 39 [ON SOLID STATE PHYSICS]. (Massachusetts Inst. of Tech., Cambridge. Solid-State and Molecular Theory Group). Jan. 15, 1961. Contract Nonr-1841(34). 103p.

A table of coupling coefficients for crystallographic point groups is given which is related to the general formulation of the problem of multiplets. A description is given of the use of the Clebsch-Gordan or vector coupling coefficients in atomic coupling theory. Calculations were made of the electronic structure of cis- and trans-bent and linear acetylene, using the self-consistent field molecular orbital method. The difference in energy between the cis- and trans-configurations is predicted, and there is a rough agreement between calculated force constants and experimental values. A density of states curve for bcc iron is given which was derived from APW calculations performed at points in the Brillouin zone. The general feature of the curve, with a high peak at high energies, a violent dip, and a broader peak at low energies, is the type known to lead to the correct ferromagnetic behavior and to the observed high specific heat of iron. Studies were continued on the effects on the magnetic field at the Fe^{57} nucleus in ferromagnets having different wave functions for electrons with two-spin orientation. This simplified method of treating magnetic correlations within atoms seems capable of giving information regarding problems of hyperfine structure and related effects. A description is given of a method for coding the Roothaan self-consistent field method for Fortran, with possible application to calculations of atomic and molecular structure. (For preceding period see NP-9522.) (B.O.G.)

13470 (NP-9867) NRL QUARTERLY ON NUCLEAR SCIENCE AND TECHNOLOGY. Progress Report for the Period October–December, 1960. (Naval Research Lab., Washington, D. C.). Jan. 1, 1961. 38p.

Papers are included which report research progress in the field of nuclear science and technology at the Naval Research Laboratory. They treat ion-optical measurements, He^3 and t reactions, stripping reactions, photoproduction, a bibliography of photonuclear reactions, coincidence probabilities, and thyratron modulator. Separate abstracts have been prepared for six of the papers. (D.L.C.)

13471 (NP-9867(p.1-7)) A RAY-TRACING TECHNIQUE FOR ION-OPTICAL MEASUREMENTS. E. A. Wolicki and A. Knudson (Naval Research Lab., Washington, D. C.).

A ray-tracing technique was devised for ion-optical measurements on electric or magnetic lens systems. The technique uses a movable aperture and a corresponding fluorescent beam spot to define the trajectory of an ion beam and was used to measure the position and size of the virtual object and to study the focal properties of a 180° magnetic spectrometer. The technique is both rapid and accurate. (D.L.C.)

13472 (NP-9876) BIBLIOGRAPHY OF HIGH TEMPERATURE CONDENSED STATES RESEARCH IN CANADA AND

ELSEWHERE, JULY TO SEPTEMBER, 1960. Norman F. G. Bright (Canada. Dept. of Mines and Technical Surveys. Mines Branch). Nov. 1960. 69p.

Available as Can., Dept. Mines and Tech. Surveys, Mines Branch, Inform. Cir. IC 122. $0.25

A bibliography is presented on work on high-temperature condensed states published in Canadian journals during the period July to Sept. 1960. Also included are bibliographies of work in this field published in Austria, Germany, Belgium, France, Scandinavia, Great Britain, the United States, and the U.S.S.R. during the period Apr. to June 1960 and in Japan during the period Jan. to Dec. 1959. (auth)

13473 (NYO-8065) ANALYSIS OF REGENERATION AND SWITCHING IN A TRANSISTOR BINARY CIRCUIT. Technical Memo. No. 63. Morton H. Lewin (Princeton Univ., N. J. Project Matterhorn). June 16, 1958. Contract AT(30-1)-1238. 38p.

The switching of a conventional transistor flip-flop is analyzed, using Laplace transform techniques. While the circuit is characterized by a regeneration region, it is possible for the switching to be such that the circuit never enters this region. Implications of this type of switching are discussed. The dependence of transition time and recovery time on circuit parameters is calculated, including a first approximation to the effect of collector capacity, which leads to an estimation of the maximum repetition rate for given transistors. Experimental verification of the difference between regenerative and nonregenerative switching is given. (auth)

13474 (NYO-8068) LINEAR CONTROL OF MONOSTABLE MULTIVIBRATOR PULSE DURATION. Technical Memo. No. 69. Herman L. Miller (Princeton Univ., N. J. Project Matterhorn). Dec. 30, 1958. Contract AT(30-1)-1238. 22p.

The characteristics of the various monostable multivibrator circuits are compared. The monostable multivibrator design equations are derived and the implications discussed, particularly with regard to linear control of pulse duration. A design procedure is given for positive and negative pulse-input cathode-coupled monostable multivibration. Performance of a monostable multivibrator designed with the procedure is discussed. (auth)

13475 (SCTM-410-60(73)) SHOCK SIGNATURES AND SPECTRA FROM RAILROAD SWITCHING LOADS. P. H. Adams (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 84p.

Tests made to obtain data on the loads that equipment is subjected to during railroad switching are described. In addition to basic data, information was sought for designing a ramp type shock-simulation facility and subsequently for comparing the characteristics of the shocks from the ramp facility with those from actual railroad switching. The data obtained are summarized in graphs of shock signature and shock spectra. (auth)

13476 (SRB-60-5) ELECTROCHEMICAL FUEL CELLS. Kenneth D. Carroll, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Nov. 1960. 53p.

An annotated bibliography of 187 references is presented of recent publications on electrochemical fuel cells, redox reactions, regenerative fuel cells, and hydrogen-oxygen fuel cell systems. (B.O.G.)

13477 (SRB-60-12) ULTRAMICROWAVE GENERATION AND DETECTION. Alfred A. Beltran, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Dec. 1960. 163p.

Concerned primarily with the generation and detection of ultramicrowaves from 30 to 300 kMc, this annotated bibliography of 270 references includes material on components, circuits, propagation, measurement, and applications. Besides the grouping of entries into five major categories with subdivisions into specific topics, an author-institute and a subject index facilitate location of specific items. A table presents the various frequency equivalents of the ultramicrowave range and defines the inclusive bands and wave lengths. (auth)

13478 (TID-11566) SOLID STATE PHYSICS SERIES: VACANCY INTERACTION COMPUTER PROGRAM 0478. J. L. McGurn and J. R. Beeler (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Sept. 1960. Contracts AF33(600)-38062 and AT(11-1)-171. 27p. (XDC-60-12-34).

The probability that two vacancies in a crystalline solid will interact depends upon the shape of the vacancy migration region in that solid. Computer Program 0478 for the IBM 704 is described which was designed to compute the vacancy migration region overlap probability in a two-dimensional solid given the shape of the migration region. This shape can be determined using GE-ANPD Monte Carlo Program 0624. (auth)

13479 (TID-11775) ANNUAL REPORT ON NUCLEAR PHYSICS RESEARCH, FEBRUARY 1, 1960–JANUARY 31, 1961. J. C. Harris, D. F. Herring, and K. W. Jones (Ohio State Univ. Research Foundation, Columbus). Jan. 31, 1961. Contract AT(11-1)-147. 19p.

Descriptions are given of the improvements in the general facilities of the laboratory and the reconstruction of the accelerator. Preliminary results are given for the elastic scattering of deuterons by N^{14} and the production of α particles in the (d,α_0), (d,α_1), and (d,α_2) reactions at 0.7 to 1.3 Mev. Observations were made of $N^{14}(d,d)$, $N^{14}(d,\alpha_1)$, $O^{16}(d,p_0)$, and $O^{16}(d,p_1)$ to measure the response and linearity of the solid-state counter. The construction and instrumentation work accomplished in the neutron program are described. Two computer programs were set up for the use of Doppler-shifted monoenergetic γ rays to study photo-excitation of nuclear states: Case I. Capture radiation directly to the ground state and Case II. Radiation coming from an excited residual nucleus after heavy-particle emission from the compound machine. (B.O.G.)

13480 (TID-11808) BOUNDS ON THE POLARIZATION AND STRAIN OF TETRAGONAL FERROELECTRIC CERAMICS. Felix Rosenthal (Clevite Research Center, Cleveland). Dec. 27, 1957. For Sandia Corp. 19p. (SCDC-2227)

Thermal maxima were computed for the polarization and strain in a polarized tetragonal ferroelectric material. Knowledge of these maxima, related to measured values, can be used to determine the relative degrees of completeness of 90 and 180° switching. (auth)

13481 (TID-12271) FORCED CONVECTION LIQUID METAL INPILE LOOP HAZARDS EVALUATION. PART I. D. Vassallo (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). June 4, 1959. Decl. Sept. 18, 1959. 21p. (TIM-602)

An evaluation and discussion of some specific potential hazards associated with the operation of the Pratt and Whitney forced-convection liquid-metal in-pile loop (designated PW-19) in the ETR are given. The effects of liquid-metal leakage to the air coolant and the reactor process water are discussed. In addition, the effects of a reactor power excursion are pointed out. (L.T.W.)

13482 (TID-12272) FORCED CONVECTION LIQUID METAL IN-PILE LOOP HOT SPOT ANALYSIS. D. B. Vassallo (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Feb. 25, 1959. Decl. Sept. 18, 1959. 21p. (TIM-578)

The results of hot-spot and hot-channel analyses performed on the Pratt and Whitney forced convection liquid-metal in-pile loop (PW-19) are reported. No excessive temperatures in the water channel were found from the hot-spot analysis, which considered only the effects due to mechanical tolerances and the uncertainties associated with the measurement of critical parameters. It is concluded that only a small probability exists that excessive temperatures will exist in the water channel during normal operation of the loop. Nuclear uncertainties were not considered in the analysis. (L.T.W.)

13483 (UCRL-6245) THE Be-FUELED ROCKET. Robert H. Fox and James S. Kane (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 1960. Contract W-7405-eng-48. 23p.

A simplified analysis was carried out on a beryllium-fueled rocket. The BeO combustion products are mixed with a nonreactive gas so that the thermal energy may be converted to kinetic energy by means of a nozzle. Energy and velocity momentum are assumed in the nozzle flow. Thermodynamic calculations show that effects due to dissociation of the gas diluent, vaporization of BeO, and BeO heat of fusion may be ignored. As diluent gas, H_2 and helium give the highest I_{sp} (within 3% of each other). Crude equilibrium calculations indicate that pressure-expansion ratios over 70 to 100 are unlikely to be useful. Therefore, the possibility of obtaining $I_{sp} > 500$ sec appears to be remote. Mission and "cost" analyses indicate, however, that $I_{sp} > 550$ sec is necessary before this becomes an interesting concept. (auth)

13484 (UCRL-9479) PHYSICS DIVISION SEMIANNUAL REPORT, MAY THROUGH OCTOBER 1960. (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 16, 1960. Contract W-7405-eng-48. 76p.

Development and operation of liquid hydrogen bubble chambers are described. The status of investigations of meson (K^-) interactions in hydrogen and deuterium is reported. Results obtained in a program of analysis of charged Σ hyperons are summarized. Theories were developed or extended for strong interactions via dispersion relations, high-energy nucleon scattering, antinucleon production, weak interactions, and other particle scattering studies. Computer programs written for various applications are described. Studies of meson (π), meson (μ), nucleon, antineutron, and deuteron interactions are summarized. Accelerator operation and development is also discussed. (M.C.G.)

13485 (UCRL-9487) ELECTRODE DAMAGE CAUSED BY SPARKS IN VACUUM. Clarence A. Harris (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 4, 1960. Contract W-7405-eng-48. 31p.

Tests were performed to determine what range of series resistance is required to protect electrodes in a vacuum from electrical discharges. Twelve hundred joules of energy stored in an external capacitor were used. A typical installation would be the high-voltage electrodes of a parallel-plate beam separator operating at (+) and (–) 600 kv. The damage to electrodes was not found to be the main factor to consider when choosing the external resistor. Maximum discharge current was limited to a value well below the expected chopping current. This allows the arc to go out immediately and possibly not restrike, giving more full-voltage operating time even with a high spark rate. A high resistance also decreases the amount of metal evaporated from electrodes, which otherwise might be deposited on insulators and give trouble. (auth)

13486 (WIS-AEC-9) THE REPULSIVE INTERACTION OF ATOMS IN S STATES. R. A. Buckingham (Wisconsin. Univ., Madison. Naval Research Lab. and London. Univ. University Coll.). Dec. 27, 1956. Contract AT(11-1)-298. 12p.

The function $V(R) = (Z_1Z_2/R)p(R)e^{-aR}$, where $p(R) = 1 + p_1R + p_2R^2 + p_3R^3 + p_4R^4$, is used to fit the repulsive potential between two atoms with nuclear charges Z_1 and Z_2. The parameters are determined from the electronic energy of the "united" atom. The results of scattering experiments and the position of the zero of V(R) are given. Detailed results are given for H-H($^3\Sigma_\mu$), H-He, and He-He interactions. (auth)

13487 (AEC-tr-4364) DETERMINATION OF THE THERMOELECTRIC POWER OF URANIUM AND PLUTONIUM. P. Costa. Translated from J. Nuclear Materials, 2: 75-80(1960). 1960. 12p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 14097.

13488 (CEA-tr-R-1048) ETUDE DES CONDITIONS D'EXCITATION DE LA STRUCTURE ISOTOPIQUE ET DE LA STRUCTURE FINE DE LA RAIE DE RESONANCE DU LITHIUM. (Study of Excitation Conditions of Isotopic Composition and of the Fine Structure Lines of Lithium Resonances). Guan-tsen Chao. Translated into French from Vestnik Moskov. Univ. Ser. Mat. Mekhan., Astron., Fiz. i Khim., No. 1: 75-8(1959). 9p.

The intensity of the components of the fine and isotopic structures of the lithium resonance line (6708 A) in a crossed cathode was studied as a function of the current intensity and gas pressure (argon). The optimum excitation conditions for the isotopic spectral analysis were defined. The argon pressure was varied from 0.3 to 2 mm Hg and the current from 20 to 70 mamp. The intensity reaches a maximum with an argon pressure of 1 mm. When the current intensity increases, the intensity of the three components increases rapidly. The effect of self-absorption on the intensity of the spectral lines was determined. (tr-auth)

13489 DIFFUSION EFFECTS IN ELECTRON BOMBARDMENT INDUCED PROCESSES. I. CATHODOLUMINESCENCE. Gy. Gergely (Research Inst. for Telecommunication, Budapest). Acta Phys. Acad. Sci. Hung., 12: 221-40(1960). (In English)

An analysis of the voltage dependence of processes induced by electron bombardment is given with consideration of the surface recombination and diffusion. The diffusion equation of DeVore is combined with Koller–Alden's, Young's and Feldman's laws relating to the dissipation of beam power and penetration of incident electrons. The cathodoluminescence is analyzed on the basis of the Schön–Klasens model. For 1 to 15 kv × 1 $\mu A/cm^2$ excitation density, the luminescence processes can be characterized by code number 122122 of Klasens in ZnS phosphors. The diffusion of minority carriers may be described by a linear differential equation. A good agreement is obtained between the theoretical and experimental brightness vs. voltage curves. By analysis of these curves, the diffusion length L and the velocity S of the surface recombination are determined. It is found that $L = 0.05$ to $0.2\ \mu$ and $S = 6 \times 10^3$ to 10^6 cm/sec for several phosphors. The lifetime and mobil-

ity of holes can be estimated in ZnS $\tau_p = 4.4 \cdot 10^{-10}$ sec, $\mu_p =$ 11 cm²/volt/sec. (auth)

13490 SPATIAL PERIOD OF MOVING STRIATIONS AS FUNCTION OF ELECTRIC FIELD STRENGTH IN GLOW DISCHARGE. M. Novak (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Czechoslov. J. Phys., 10: 954-9(1960). (In English)

During a systematic investigation of the parameters of a moving stratification in a glow discharge in helium and neon it was found that the spatial period of the striations λ is a simple, unique function of the d-c (constant) component of the longitudinal electric field strength E. It was found that this dependence is hyperbolic. In the relation, $\varphi\lambda$ has the significance of a potential fall between the corresponding points of two neighboring striations and in the measured range of pressures, currents, and diameters of discharge tubes it depends only on the sort of gas and type of striations. (auth)

13491 BUILDING OF ASYMPTOTIC EXPANSIONS FOR WEAK INTERACTIONS ON THE FORMAL THERMODYNAMIC THEORY OF PERTURBATIONS IN A MODIFIED STATEMENT OF THE PROBLEM OF BOSE-EINSTEIN'S NON-IDEAL SYSTEM. V. V. Tolmachev (Karpov Inst. of Physics and Chemistry, [USSR]). Doklady Akad. Nauk S.S.S.R., 135: 41-4(Nov. 1, 1960). (In Russian)

The special diagram appearing in the statistical variable principle of V. V. Tolmachev, Doklady Akad. Nauk, 134: 1960, is considered as a summation for reconstructing the theory of perturbations and for establishing asymptotic expansion for weak interactions of given magnitudes. Two approximations are analyzed, and the results are generalized in two directions: the "step-like" summation, where the interaction is replaced by renormalization, thus relating the results of the analysis to a so-called pair interaction approximation; and the "density" summation for studying collective excitations, which is equivalent to the chaotic-phase approximation in plasma theory. The developed improvements do not eliminate the shortcomings of an expansion at critical and near-critical temperatures. (R.V.J.)

13492 ON THE STABILITY OF A CASE OF SPHERICAL CONVERGING SHOCK WAVE. R. M. Zeidel and V. S. Lebedev. Doklady Akad. Nauk S.S.S.R., 135: 277-9(Nov. 11, 1960). (In Russian)

The stability of strong spherical converging shock waves in an ideal gas with an isentropic index of $\gamma = 7$ was analyzed. (R.V.J.)

13493 SOME PROPERTIES OF THE CESIUM PLASMA OF A THERMOELECTRON ENERGY CONVERTER. N. D. Morgulis and Yu. P. Korchevoi (Kiev State Univ.). Doklady Adad. Nauk S.S.S.R., 136: 336-8(Jan. 11, 1961). (In Russian)

Data on electron temperature, electron concentration and plasma potential in relation to anode V_p were determined by developed probe characteristics. The magnitudes for $T_c =$ 2050°K and various values of t and T_c are tabulated for short circuit operation and operation with optimum power yield. The data indicate no clearly expressed relation between electron temperature T_e, cathode temperature T_c, and anode temperature T_a or the transformation parameters N_e. The magnitude of T_e in short-circuit operation is smaller than in optimum power operation, though a reverse condition was anticipated. Electron concentrations N_e are of considerable magnitude even when they correspond to a low ionization in Cs vapors and the intrinsic potential V_p can be higher or lower than the anode potential. The unexpected influence of Cs vapor pressure on plasma parameters prompted further investigations. Data plotted for the V_p, N_e, T_e, and J_o as functions of t at $T_c = 2050$°K show two different modes of converter operation with a definite boundary at t ≈ 145°C. (R.V.J.)

13494 COMBINED DIFFUSION OF PHOTONS AND EXCITED ATOMS. B. A. Beklenko (Moscow Inst. of Power Engineering). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 64-74(1960). (In Russian)

A Green's function is derived for the equation describing the combined diffusion of photons and excited atoms in an infinite homogeneous space. The asymptotic properties of the equation are analyzed, and the physical conditions under which certain mechanical transposition can be neglected are determined. (tr-auth)

13495 STUDIES OF PULSE DISCHARGE AT REDUCED INTENSITY. N. A. Korinevskaya and L. A. Spektorov (Kirgiz State Univ., [USSR]). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 182-9(1960). (In Russian)

The break-down potentials and discharge quenching in air were studied as functions of pulse durations from 0.5 to 10 μsec, and frequencies from 100 to 3000 pulses/sec at 3 to 100 mm Hg. Close to the quenching potential, the discharge formation time and the detonation time increase with increased pressure. (tr-auth)

13496 STUDIES OF HIGH-FREQUENCY DISCHARGE AT 1.5 TO 15 Mc. [PART] II. A. A. Kuzovnikov and Chien Kao-yun (Moscow State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 5, 55-9(1960). (In Russian)

The photocurrent of an element illuminated by discharge radiation and the current shocks appearing in high-frequency corona discharge and in transitional discharge were oscillographed. The data obtained by means of a rotating disk in a high-speed camera and in a Kerr cell are given. (tr-auth)

13497 THE THOMAS–FERMI AND THOMAS–FERMI-DIRAC EQUATIONS CONSIDERING PARTIALLY SATURATED ELECTRON SHELLS. A. N. Men (Sverdlovsk Inst. of Agriculture, [USSR]). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 5, 112-17(1960). (In Russian)

Thomas–Fermi and Thomas–Fermi–Dirac equations were derived considering partially saturated shells, and specific Thomas–Fermi and Thomas–Fermi–Dirac equations were developed for atoms with saturated shells. (tr-auth)

13498 LUMINESCENCE GLOW OF ZINC SULFIDE PHOSPHORS AT DAMPING TEMPERATURE. L. A. Suvorova (Siberian Inst. of Physics and Tech., Tomsk State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 5, 124-30(1960). (In Russian)

The glow process and luminescence damping at various temperatures were studied in ZnS–Cu(Cu, 10^{-4} g/g); ZnS–Cu, Fe(Cu, 5×10^{-5} g/g), Fe(2×10^{-6} g/g); and ZnS–Cu ($\phi K\pi$). The effects of excitation intensity on the glow process were investigated, and a formula was developed for describing luminescence glow at damping temperatures. (tr-auth)

13499 ELECTRON AND ION EMISSION OF METAL FILM CATHODES IN CESIUM VAPORS. N. D. Morgulis and Yu. P. Korchevoi (Shevchenko Kiev State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 5, 137-42 (1960). (In Russian)

Electron and ion emission by barium–tungsten and barium–nickel cathodes in cesium vapor were investigated. The data indicate a considerable and typical adsorption effect exerted by cesium vapors on electron emission by

cathodes with barium and a considerable thermal ionization of the cesium vapor at the cathode surface. (tr-auth)

13500 INVESTIGATION OF HIGH-FREQUENCY DISCHARGE AT 1.5 TO 15 Mc. A. A. Kuzovnikov and N. A. Kaptsov (Moscow State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 6, 64-70(1960). (In Russian)

The mechanism of stabilized high-frequency corona discharge and its transition into glow discharge are described. The mechanism of the development of the high-frequency corona discharge is described by avalanche theory, and glow discharge is developed by a gradual formation of high-frequency plasma. The high-frequency corona discharge turns into glow discharge when the active stream half-period is less than 0.03 μsec. (tr-auth)

13501 DISCHARGE INTENSITY OF SHORT PULSE ARC. A. S. Zingerman and D. A. Kaplan (Kirov Tomsk Polytechnic Inst.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 6, 165-6(1960). (In Russian)

The discharge intensity and shape of a short-pulse arc depend on the cathode material and in a smaller degree on the anode material. The medium between the electrodes does not affect either the form or the magnitude of the discharge intensity. This indicates that the discharge takes place in the vapors of the electrode materials. (R.V.J.)

13502 ANALYSIS OF REACTIVE SCATTERING IN CROSSED MOLECULAR BEAMS. Dudley R. Herchbach (Univ. of California, Berkeley). J. Chem. Phys., 33: 1870-1(Dec. 1960). (UCRL-9377)

Several effects that must be taken into account in an interpretation of results obtained in a study of the K + HBr → H + KBr reaction in crossed molecular beams are discussed. If the collision yield is measured at a fixed laboratory angle while the speed of one of the beams is varied, the orientation of the velocity vector and the center-of-mass vector with respect to the direction of observation will change continually. This would cause the dependence on the velocity vector and the dependence on the angle between the velocity vectors to be superposed in the results. Results indicated that this would cause a modification of the results obtained for relative initial kinetic energy. (M.C.G.)

13503 CALCULATION OF THE LOWER EXCITED ENERGY LEVELS OF HELIUM. H. F. Hameka (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 34: 884-6(Mar. 1961).

The energies of the 1^1S, 2^1S, 2^1P, and 2^3P states of helium were calculated according to a method due to Pluvinage. It was shown that the Coulomb electronic repulsion term may be replaced by an effective potential function that accounts for first-order electronic repulsion effects on the wave functions. The deviations between calculated and experimental energy values vary between 0.01 and 0.06 a.u. (auth)

13504 PARAMAGNETIC RESONANCE ABSORPTION IN NAPHTHALENE IN ITS PHOSPHORESCENT STATE. Clyde A. Hutchison, Jr. and Billy W. Mangum (Univ. of Chicago). J. Chem. Phys., 34: 908-22(Mar. 1961).

Paramagnetic resonance absorption was observed in naphthalene in solid solution in a single crystal of durene when irradiated with light from an A-H6 mercury lamp. The fine structure of the spectrum at a frequency of $\sim 22.7 \times 10^9$ cps may be described by the spin-Hamiltonian $\mathcal{H} = |\beta|\mathbf{H} \cdot \mathbf{g} \cdot \mathbf{S} + D S_z^2 + E(S_x^2 - S_y^2)$, with $S = 1$, $g = 2.0030 \pm 0.0004$ (isotropic), $D/hc = \pm 0.1003 \pm 0.0006$ cm^{-1}, $E/hc = \mp 0.0137 \pm 0.0002$ cm^{-1}. Observations at a different frequency, $\sim 9.7 \times 10^9$ cps, and also measurements on perdeuteronaphthalene are described by essentially the same parameters. The fine structure data identify the spectrum as arising from a triplet state and leave no doubt as to the triplet character of the phosphorescent state of naphthalene. The zero-field splitting of the triplet has its origin in the magnetic dipole-dipole interaction between the two unpaired electrons in the triplet state. Hyperfine structure was observed and is interpretable on the basis of the anisotropic hyperfine interaction constants for a C-H fragment given by McConnell. The π-electron spin density on the α carbons is found to be 0.209. The hyperfine structure results identify the spectrum as arising from naphthalene. The triplet state is $^3B_{2u}^+$ and the naphthalene molecules are oriented in the crystals such that they are not only coplanar with the durene molecule, which they replace, but also have their long and short twofold axes in this plane parallel, respectively, to the long and short axes of durenes. (auth)

13505 NEW DETERMINATIONS OF THE VIBRATIONAL CONSTANTS OF Li^6F AND Li^6Cl^{35} BY THE MOLECULAR BEAM ELECTRIC RESONANCE METHOD. T. I. Moran and J. W. Trischka (Syracuse Univ., N. Y.). J. Chem. Phys., 34: 923-8(Mar. 1961).

New measurements of the vibrational constants of LiF and LiCl were stimulated by the hypothesis of Klemperer and Herschbach that disagreement between infrared and previous molecular beam values of these constants could be explained by a variation in the efficiency of the molecular beam detector with vibrational state. The new molecular beam results rule out this hypothesis because of their agreement with infrared results. These new values are 930 ± 19 cm^{-1} for Li^6F and 705 ± 14 cm^{-1} for Li^6Cl^{35}. The agreement of these values with the infrared results leads to the conclusion that the vibrational states of molecules in the molecular beam source have a Boltzmann distribution. The relative detector efficiency for the vibrational states $v = 0$ and $v = 1$ did not vary when the total efficiency was changed over a range from 0.2 of the maximum value to the maximum. The ratio of the vibrational constants of Li^6F and Li^7F was found to be 1.06 ± 0.01, in agreement with the value calculated from the ratio of the reduced masses. A rough measurement of the vibrational decay constant between the $v = 1$ and $v = 0$ states gave 65 ± 40 sec^{-1}. (auth)

13506 INTERACTION OF A TRIPLET AND A NORMAL HELIUM ATOM. G. H. Brigman (Convair, Fort Worth, Tex.), S. J. Brient, and F. A. Matsen. J. Chem. Phys., 34: 958-60(Mar. 1961).

The electronic energy of the system $He(^1S)$ and $He(^3S)$ was calculated as a function of nuclear separation. This calculation differs from an earlier one by R. A. Buckingham and A. Dalgarno [Proc. Roy Soc. (London) A213, 327 (1952)] in three ways: the use of a nodeless 2s function, the use of an open-configuration wavefunction (1s1s′) for $He(^1S)$, and the use of orbital exponents optimized for each internuclear distance. The energy obtained lies approximately 1 volt below the earlier calculation but confirms it in all qualitative aspects, including the presence of a "hump" at $R \cong 4a_0$. (auth)

13507 THE KINETICS OF DISSOCIATION OF A DIATOMIC GAS. H. O. Pritchard (Univ. of Manchester, Eng.). J. Phys. Chem., 65: 504-10(Mar. 1961).

The collision theory of chemical reactions is developed to a point where it is capable of describing the mechanics of the dissociation and recombination of a diatomic gas. The experimental observation of activation energies for dissociation which are substantially less than the heat of dissociation appears to be due to a failure to maintain an

equilibrium population among the highest vibrational energy levels. Since the dissociation process is thermodynamically irreversible, there is no simple relation between the dissociation and recombination rate constants and, therefore, no correspondence between the heat of dissociation and the activation energies for the two processes. (auth)

13508 SOUND PROPAGATION IN A DILUTE FERMI GAS AT ZERO TEMPERATURE. K. Gottfried and L. Picman (Univ. of Copenhagen; Harvard Univ., Cambridge, Mass.; and Institut "Jozef Stefan", Ljubljana, Yugoslavia). Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd., 32: No. 13, 1-29(1960). (In English)

Landau showed that a nonideal Fermi gas at zero temperature can sustain collective oscillations of the acoustical type (zeroth sound). The attenuation of zeroth sound in a dilute Fermi gas with repulsive interactions was considered. The problem was formulated in terms of the Green function G which describes the propagation of density fluctuations through the system. The simplest approximation of G led to Landau's dispersion law which was analyzed in some detail. The contribution of the phonons' zero point oscillations to the ground-state energy was estimated and found to lead to a term which has an essential singularity at the origin of the coupling constant plane. The energy and width of the phonon are given by the poles in the spectral representation of G, and the location of these poles was determined from the Fredholm solution of an approximate integral equation satisfied by G. In this way it is shown that the width, divided by the displacement of the collective state above the single-particle continuum of the free gas, vanishes linearly in the long wavelength limit. It is also shown that in the limit of extreme dilution the correct damping can be obtained by merely taking the finite lifetime of single-particle excitations into account and ignoring the dissipative effects of the noninstantaneous interactions between the particles in the medium. Finally, it is also argued that the Fredholm method is the natural tool for discussing many problems in the theory of collective motion. (auth)

13509 ISOTOPE SHIFTS IN THE NMR SPECTRA OF H_2, HD AND D_2 DUE TO ZERO-POINT VIBRATION. T. W. Marshall (National Physical Lab., Teddington, Eng.). Mol. Phys., 4: 61-3(Jan. 1961).

The variation with interatomic separation of the nuclear magnetic screening constant for H_2 is considered. An estimate is made of the difference in screening which is a consequence of the different zero-point vibrational functions in H_2, HD, and D_2. (auth)

13510 ELECTRON SPIN RESONANCE OF $(CO_2H)CH_2-CH(CO_2H)$ IN SUCCINIC ACID. D. Pooley and D. H. Whiffen (Univ. of Birmingham, Eng. and National Physical Lab., Teddington, Eng.). Mol. Phys., 4: 81-6(Jan. 1961).

Electron-spin-resonance investigations on a γ-irradiated single crystal of succinic acid confirm and extend the findings of Heller and McConnel on the hyperfine couplings in the radical $(CO_2H)CH-CH_2(CO_2H)$. Complete coupling tensors, and the g tensor, are given in the table. These confirm that the radical has almost the same orientation as the unchanged molecules. The plane of the free-radical carbon is twisted 5° from the original carbon skelton plane, and this leads to appreciable nonequivalence of the hydrogen atoms of the CH_2 group. (auth)

13511 TRITIUM AS A SOURCE OF RADIATION IN ELECTRON SPIN RESONANCE STUDIES. Jerzy Kroh, Basil C. Green, and John W. T. Spinks (Univ. of Saskatchewan, Saskatoon). Nature, 189: 655-6(Feb. 25, 1961).

A common difficulty encountered in electron-spin-resonance investigations of materials irradiated by high-energy radiations is the appearance of the electron-spin-resonance spectrum of irradiated glass or quartz tubes containing the samples. This difficulty was avoided by using internally emitted T β particles as the source. Solutions of tritium oxide in water, deuterium oxide and water, plus deuterium oxide mixtures with activities 100 mc/ml and 1 curie/ml, were frozen in glass tubes in liquid nitrogen, and the electron-spin-resonance spectra of the samples were examined at the liquid-nitrogen temperature. After applying doses of radiation up to 5×10^{20} ev/ml, no effects of the irradiated glass on electron-spin-resonance spectra were observed. (C.H.)

13512 INFLUENCE OF TEMPERATURE AND BOMBARDMENT RATE ON DISORIENTATION OF SILVER SINGLE CRYSTALS BY ION BOMBARDMENT. G. J. Ogilvie and A. A. Thomson (Commonwealth Scientific and Industrial Research Organization, Melbourne). Phys. and Chem. Solids, 17: 203-9(Jan. 1961). (In English)

Single crystals of silver with (1 1 0), (0 0 1) and (1 1 1) planes parallel to the surface were bombarded by positive ions of argon having an energy of 130 ev at constant temperatures in the range 100 to 400°C. Transmission electron diffraction patterns obtained from thinned regions in the crystals show that disoriented crystallites and stacking disorders are caused by the bombardment. The effects due to disoriented crystallites decrease in intensity as the temperature of bombardment increases. It is shown that the disorientation increases with increasing current density of ions, and the change in disorientation with annealing is studied. The application of the results to the problem of producing clean surfaces by ion bombardment is discussed. It is shown that thermal annealing is not sufficient to account for the change in disorientation with bombardment temperature. The possibility is examined that point defects introduced by bombardment accelerate annealing. (auth)

13513 DIELECTRIC CONSTANT, DENSITY, EXPANSION COEFFICIENT, AND ENTROPY OF LIQUID He^3 UNDER PRESSURE BELOW 1°K. D. M. Lee, Henry A. Fairbank, and Edward J. Walker (Yale Univ., New Haven). Phys. Rev., 121: 1258-65(Mar. 1, 1961).

By measuring the resonant frequency of an LC circuit containing a capacitor filled with liquid He^3, the dielectric constant of the liquid was measured from 0.14 to 1°K at several pressures from 0.2 to 29.5 atm. From these measurements the density, expansion coefficient at constant pressure, and the change in entropy on compression from saturated vapor pressure to higher pressures were determined. α_p was found to be negative and, hence, $(\partial S/\partial P)_T$ positive for all pressures below a certain temperature, which increased monotonically with pressure. A minimum in the melting curve of He^3 was found at $T = 0.32 \pm 0.01$°K and $p = 29.1 \pm 0.1$ atm. (auth)

13514 MODES OF ATOMIC MOTIONS IN LIQUID HELIUM BY INELASTIC SCATTERING OF NEUTRONS. D. G. Henshaw and A. D. B. Woods (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Phys. Rev., 121: 1266-74(Mar. 1, 1961).

The wavelength distribution of 4.03 Å neutrons, scattered inelastically by specimens of liquid helium, was measured at 30 angles of scattering in the range 10 to 140°. At each angle of scattering there is a discrete peak which shows little broadening and little if any excess scattering outside this peak. The changes in energy and momentum corresponding to the change in wavelength of the scattered neutrons are calculated for each angle of scattering. The dispersion curve in the liquid is similar in form to that pre-

dicted theoretically but there are differences in detail. For momentum changes ($\hbar Q$) in the range $0.26\ A^{-1} \leq Q \leq 0.6\ A^{-1}$, the measurements fall on a straight line which has a slope given by the velocity of sound. The maximum and the minimum of the curves occur at $1.10\ A^{-1}$ and 13.7°K and at $1.91\ A^{-1}$ and 8.65°K, respectively. Beyond the minimum the curve starts to rise with a slope equal to or less than the phonon branch and then falls below this, suggesting the possible existence of a second maximum. The relative partial differential cross section for the production of a single phonon excitation is low at low momenta, has a maximum in the region of $2.0\ A^{-1}$, and then decreases rapidly to low values in the region of $2.68\ A^{-1}$. The position of the maximum may be compared with $2.05\ A^{-1}$, the maximum in the total differential cross-section curve and $1.91\ A^{-1}$, the minimum of the dispersion curve, respectively. The widths and mean energy change of neutrons scattered through 80° were measured at 13 temperatures in the range 1.78 to 4.21°K. Scattering at this angle corresponds to the production of excitations at the minimum of the dispersion curve. The mean energy change decreases rapidly from a value of 8.6$_5$°K at 1.1°K to 5.6°K at the λ temperature where there is a marked change in slope and only a much slower decrease above the λ temperature to 4.9°K at 4.2°K. The widths of the spectra increase rapidly from a value of < 1°K at 1.1°K to 11°K at the λ temperature where there is also a marked change in slope and only a much slower increase to about 15°K at 4.2°K. The measured widths are compared with theoretically calculated widths. (auth)

13515 COLLISION THEORIES OF CATHODE SPUTTERING OF METALS AT LOW ION ENERGIES. Erich B. Henschke (Wright Air Development Div., Dayton, Ohio). Phys. Rev., 121: 1286-95(Mar. 1, 1961).

The periodicity of the threshold energies, as seen in a plot vs. atomic number, is more pronounced for threshold energies determined from the part of the yield curve at the lowest ion energies, which obeys a quadratic law, than for "cut-in" energies determined with a linear law from the adjacent somewhat higher ion energy range. The relation of the "empirical sputtering relation" with the threshold formula is clarified. It is shown that in the case that the rebounding particle is believed to be a displaced target atom, the assumption of a very large "effective" mass of the struck atom must also be made to explain the rebound at angles as observed in ejection patterns of single-crystal planes. Arguments are presented that this model is consistent with the observed higher yields of metals with completely filled d shells, such as copper, silver, and gold. The energy losses connected with the impulses used up in Debye waves are in good agreement with the energy losses in similar collisions. (auth)

13516 APPEARANCE AND EFFECT OF THE DEBYE-WALLER FACTOR IN THE TRANSPORT COEFFICIENTS OF SIMPLE NORMAL METALS. M. Bailyn (Northwestern Univ., Evanston, Ill.). Phys. Rev., 121: 1336-43(Mar. 1, 1961).

Analogous to the theory of the diffraction of x rays and neutrons by the lattice vibrations of crystals, the scattering of electrons in a metal by thermal vibrations gives rise to a temperature-dependent Debye-Waller factor in the matrix element. The factor was derived and its possible effects on electrical resistivity discussed for the case where Bloch functions are used for the electron wave function. A detailed numerical calculation for an umklapp process involving a particular phonon was performed, for rubidium at room temperature, with the result that the new matrix element is about 0.7 times the 1937 Bardeen result, and consequently the contribution to the resistivity about 0.5 times the Bardeen value. It is even a possibility that, for some phonons, the matrix element may increase. (auth)

13517 ELECTRON TEMPERATURE DEPENDENCE OF THE RECOMBINATION COEFFICIENT IN PURE HELIUM. C. L. Chen, C. C. Leiby, and L. Goldstein (Univ. of Illinois, Urbana). Phys. Rev., 121: 1391-1400(Mar. 1, 1961).

The phenomenon of "afterglow quenching" was employed to determine the electron temperature dependence of the electron-ion recombination coefficient in plasmas produced in purified helium (estimated impurity $1 : 10^5$). The total visible light intensity was studied as a function of electron temperature. By means of 1.5% bandwidth filters, the light intensity of two helium spectral lines (5876 A and 3888 A) was also investigated. It was found that the recombination coefficient for highly purified helium varied as the minus three-halves power of the electron temperature from 300 to ~ 1500°K, at electron densities of $\sim 10^{11}/cm^3$, and gas pressures from 12.6 to 30.3 mm Hg. At 300°K (temperature determined from collision frequency measurements), the recombination coefficient in purified helium was found to be $(8.9 \pm 0.5) \times 10^{-9}\ cm^3/ion\ sec$. It was found that both the recombination coefficient and its electron temperature dependence are strongly influenced by the addition of controlled amounts (2×10^{-4} to 1300×10^{-4}%) of neon impurities. (auth)

13518 THE ENTROPY OF HELIUM II UNDER PRESSURE FROM MEASUREMENTS ON THE FOUNTAIN EFFECT. C. J. N. Van den Meijdenberg, K. W. Taconis, and R. De Bruyn Ouboter (Kamerlingh Onnes Laboratorium, Leiden). Physica, 27: 197-218(Feb. 1961). (In English)

Assuming that London's formula, $\Delta p = \rho S \Delta T$, is also valid for the fountain effect in helium II at high pressures, the entropy as a function of temperature and pressure was evaluated from measurements of the fountain effect in the temperature range 1.15 to 2.00°K and at various pressures between the saturated vapor pressure and 25 atm. On extrapolating the entropy data as a function of pressure to the saturated vapor pressure good agreement was found with the entropy values of Kramers e.a.., the deviations being smaller than 2%. The entropy data of Lounasma and Kojo at different densities were fitted to the present entropy data to obtain an entropy diagram up to the λ-curve. As, however, the various data on the density of liquid helium do not agree there is some doubt with respect to this fit. Finally, values were determined for the parameters of the proton spectrum at several pressures. The results were discussed and compared with those obtained from experiments on inelastic neutron scattering. (auth)

13519 SOME THERMODYNAMIC CONSIDERATIONS ON THE PROPERTIES OF LIQUID He^3–He^4 MIXTURES. R. De Bruyn Ouboter and J. J. M. Beenakker (Kamerlingh Onnes Laboratorium, Leiden). Physica, 27: 219-29(Feb. 1961). (In English)

The stratification curve for liquid He^3–He^4 mixtures shows a singularity at the junction with the lambda curve as can be seen on the basis of pure thermodynamic considerations. If the lambda curve and the stratification curve meet each other under a finite angle, there is a discontinuity in the slope of the stratification curve and in the specific heat at this point. Furthermore, the entropy of dilute mixtures is discussed with respect to Nernst's theorem. (auth)

13520 STATISTICAL MECHANICAL DERIVATION OF THE GENERALIZED BOLTZMANN EQUATION FOR A FLUID CONSISTING OF RIGID SPHERICAL MOLECULES. J. V. Sengers and E. G. D. Cohen (Gemeente Universiteit, Amsterdam). Physica, 27: 230-44(Feb. 1961). (In English)

An analysis is made as to whether the modified Boltzmann equation originally proposed by Enskog with intuitive arguments can be justified by a statistical mechanical derivation. In a preceding paper the theory of Bogolubov and the theory of Kirkwood as to the derivation of a generalized Boltzmann equation for a dilute gas were compared and it was proved that corrections to the ordinary Boltzmann equation due to the first order terms of an expansion in terms of a uniformity parameter μ are equal. In the present paper both theories are applied to a dense system of rigid sperical molecules. It is shown that both theories give again a similar equation for the first distribution function, leading under a number of assumptions to the Enskog equation. In some publications it was stated that the theory of Kirkwood would lead to an equation for the first distribution function essentially different from the Enskog equation and suggestions were raised elsewhere that this disparity might be due to the integration procedure applied to the Liouville equation, which would not be legitimate for a discontinuous rigid sphere potential. On the contrary to this the present derivation shows that also in the theory of Kirkwood the Enskog equation can be obtained from the general (N−1) times integrated Liouville equation. (auth)

13521 THE ENERGY TRANSFERRED IN INELASTIC ION-ATOM COLLISIONS. J. B. Hasted (University Coll., London). Proc. Phys. Soc. (London), 77: 269-72(Feb. 1, 1961).

Multiply charged target ion abundances for Ne^+ collisions with argon at 75 kev are calculated. The electron energy distribution for hard scattering is also calculated; this calculation shows a maximum at about 200 ev. (auth)

13522 SCATTERING OF ELECTRONS BY THE THERMAL MOTION OF IMPURITY IONS. [PART] II. Shigeharu Koshino (Radiation Center of Osaka Prefecture, Sakai). Progr. Theoret. Phys. (Kyoto), 24: 1049-54(Nov. 1960). (In English)

The change of electrical resistance of dilute alloys due to the thermal motion of impurity ions at low Kelvin temperatures (T) is calculated by a variational method. The obtained change of electrical resistance depends on T^2 at the limit of low temperature, and its magnitude is larger than that of the normal phonon-scattering resistance when the temperature is sufficiently low. (auth)

13523 SPECTRAL FLUX DENSITY OF SCATTERED AND PRIMARY RADIATION GENERATED AT 250 Kv. L. D. Skarsgard and H. E. Johns (Univ. of Toronto). Radiation Research, 14: 231-60(Mar. 1961).

Methods were developed for the determination of the spectral distribution of the radiation at a point within the scattering medium. Measurements in the 250-kev range are reported. The spectral distributions for a variety of depths and field areas in a water phantom were determined for half-value layers ranging from 1 to 3 mm copper. The spectra of the primary, scattered, and total radiation were determined absolutely. Depth-dose data calculated from these spectra are in excellent agreement with published data. The results of the measurements are given in tables in which the spectral number flux density in photons per square centimeter per 10 kev for 100 r in air is presented. (M.C.G.)

13524 THE VISCOSITY OF LIQUID SULFUR. Tomoo Matsushima (Research Inst. of Mineral Dressing and Metallurgy, [Japan]). Sci. Repts. Research Insts., Tohoku Univ., Ser. A, 11: 474-81(Dec. 1959). (In English)

The viscosity of pure sulfur and the effect of selenium, arsenic, and organic substances on its viscosity were determined in the temperature range between 120 and 160°C. The viscosity of pure sulfur vs. temperature is normally represented by the experimental formula of $\eta = Be^{A/T}$ until the ascending temperature reaches about 155°C. In the equation, which directs the linear relation between the logarithm of the viscosity and the reciprocal of the absolute temperature, the viscosity is reduced to minimum near 155°C, and then gradually rises in the neighborhood of 159°C. Further, a sudden increase of the viscosity was observed when temperature reached 160°C. It is considered that the critical point of the formation of polymer sulfur exists in the temperature defined by these narrow ranges. Selenium dissolved in sulfur caused no remarkable change in viscosity, but it was considered to cause a slight depression in the critical point whose temperature is in the neighborhood of 159 to 160°C for pure sulfur. The viscosity of sulfur containing arsenic had a value noticeably higher than that of pure sulfur. The change in viscosity should be demonstrated in other phases such as the equilibrium system on the variation of the molecular species of sulfur and arsenic. The results showed that the minimum point was reduced to lower temperature, according to the increase in arsenic content in sulfur. The organic substances from charcoal tar or coal tar caused no change in viscosity. Distinct differences were not observed in various heat-treated samples below 160°C. So, the effect of the organic substances is considered to be small. (auth)

13525 MAJOR ACTIVITIES IN THE PROGRAMS OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, OCTOBER 1, 1959–MARCH 31, 1960. (National Aeronautics and Space Administration, Washington, D. C.). 1960. 189p.

A report is presented on the major activities of the National Aeronautics and Space Administration (NASA) from Oct. 1, 1959, through March 31, 1960. The current status of NASA programs is briefly summarized, and progress in NASA aeronautics and space research and development is described in detail. Satellites, manned flight, tracking, propulsion systems, the NASA organization, and a financial statement of the NASA are included. (D.L.C.)

13526 PROCEEDINGS OF THE VIIth INTERNATIONAL CONFERENCE ON LOW TEMPERATURE PHYSICS, UNIVERSITY OF TORONTO, CANADA, 29th AUGUST–3rd SEPTEMBER, 1960. G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961. 742p. $15.00.

About 220 papers and discussion presentations from the conference are included in this record of the conference. The thirty topics discussed include the following: Mössbauer effect, magnetic relaxation, liquid and gaseous H_2, magnetism, polarization of protons, nuclear orientation, Fermi surface, ultrasonic attenuation, resistance minima, transport properties in solids, superconductivity, flow properties of liquid He^4, Kapitza boundary layer, ions in liquid helium, helium film, properties of He^4, liquid and solid He^3, thermodynamic properties of He^3–He^4, equation of state and thermodynamic properties, thermodynamic properties of argon, and proposal for a He^3 temperature scale. Abstracts have been prepared for 69 of the papers. (T.R.H.)

13527 THE EFFECT OF RELAXATION PHENOMENA ON MÖSSBAUER EXPERIMENTS. W. Low (National Research Council, Ottawa). p.20-2 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The sharp lines observed in the Mössbauer type experiments have been used to investigate the local magnetic fields acting on the radioactive nucleus. The broadening

mechanisms found in spin resonance are shown to be useful in studying relaxation phenomena in magnetic materials. The complications involved are pointed out. (T.R.H.)

13528 EXPERIMENTAL ASPECTS AND APPLICATIONS OF THE MÖSSBAUER EFFECT. Paul P. Craig (Los Alamos Scientific Lab., N. Mex.). p.22-35 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Criteria for existence of the Mössbauer effect are established, and experimental uses are reviewed. A tabulation of the properties of Mössbauer nuclei is presented. (T.R.H.)

13529 QUANTUM PROPERTIES OF GASEOUS H_2 AND D_2 AT LOW TEMPERATURES. M. J. Offerhaus and J. de Boer (Universiteit, Amsterdam). p.81-3 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A comparison is made of the properties of hydrogen and D_2 gases at low temperatures. Numerical details are taken from theoretical studies based on a spherically symmetric intermolecular potential of Lennard-Jones (12-6) type V(r). The largest quantum effects are caused by diffraction. On a smaller scale, symmetry effects exist. (T.R.H.)

13530 MAGNETIC DIPOLE INTERACTION IN DYSPROSIUM ETHYLSULPHATE. A. H. Cooke, D. T. Edmonds, C. B. P. Finn, B. R. Heap, and W. P. Wolf (Clarendon Lab., Oxford). p.107-8 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Measurements were made of the magnetic susceptibility, entropy, and specific heat of dysprosium ethylsulfate down to the transition point. It is verified that below this point the effective susceptibility of a specimen is determined by its demagnetizing factor. On one specimen extensive measurements were made of susceptibility in steady fields and the in-phase and out-of-phase components of susceptibility in alternating fields to study relaxation effects. (T.R.H.)

13531 NUCLEAR SPIN SUSCEPTIBILITY OF HD BELOW 1°K. D. C. Freeman, Jr. (Linde Co., Tonawanda, N. Y.). p.135-8 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The derivative of the proton nuclear resonance absorption signal for HD was measured down to 0.2° using adiabatic demagnetization. The nuclear susceptibility showed no deviation from Curie's law and no evidence of line splitting. (T.R.H.)

13532 EXPERIMENTS ON DYNAMIC POLARIZATION OF PROTONS IN POLYETHYLENE BY THE SOLID EFFECT. A PROPOSED POLARIZED PROTON TARGET. Chester Hwang and T. M. Sanders, Jr. (Univ. of Minnesota, Minneapolis). p.148-52 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The polarization of protons in irradiated polyethylene was studied using a two-bolometer ESR spectrometer operated near 9000 Mc. The external magnetic field of 3500 gauss was modulated at 280 cycles. The proton polarization is measured by monitoring the ratio of the intensity of the UMR signal in the presence of the microwave radiation to the NMR signal in thermal equilibrium. A maximum value of 1.2% at 1.2°K was found. (T.R.H.)

13533 DYNAMICAL POLARIZATION OF PROTONS IN HIGH FIELDS. M. Borghini (Centre d'Études Nucléaires, Saclay, France). p.152-5 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A study was made of the relaxation processes and polarization of protons contained in double nitrates of magnesium and lanthanum with 0.1 to 20% Ce^{+++}. The measurements were made between 1.5 and 2.1°K using magnetic fields of about 13,500 gauss, and at frequencies around 34 Mc. In the experiments, measurements were made of the enhancement of the proton polarization and the transient phenomena occurring when the microwave irradiation is suddenly switched on or off. There is rough agreement with theory. (T.R.H.)

13534 POLARIZATION OF NUCLEI OF WEAKLY MAGNETIC ELEMENTS INTRODUCED IN FERROMAGNETS. B. N. Samoilov, V. V. Sklyarevskii (Sklyarevsky), and E. P. Stepanov (Inst. for Atomic Energy, Academy of Sciences, Moscow). p.171-3 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A method is proposed for polarizing nuclei of weakly magnetic elements by adding them to a ferromagnet. The ferromagnetic alloy of the element is cooled to 10^{-3}°K, and the nuclei throughout each domain become polarized owing to the hyperfine interaction of their magnetic moments with the ferromagnetic alloy electrons. A comparatively weak external field (~1000 gauss) magnetizes the ferromagnet to saturation, polarizing the nuclei with respect to the field. Application of the method to Au, Sb, In, Au–Gd, In–Ni, and Au–Ni alloys using γ-ray anisotropy is discussed. (T.R.H.)

13535 SOME RECENT DEVELOPMENTS IN THE THEORY OF SUPERCONDUCTIVITY. P. W. Anderson (Bell Telephone Labs., Murray Hill, N. J.). p.298-310 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A review is presented on superconductivity studies during 1958 to 1960. The emphasis is on use of the Bardeen-Cooper-Schrieffer (BCS) method to predict and understand the properties of real superconductors. (T.R.H.)

13536 SUPERCONDUCTING PROPERTIES OF THE TWO MODIFICATIONS OF MERCURY. C. A. Swenson and J. E. Schirber (Ames Lab., Ames, Iowa). p.338-45 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961. (IS-195)

Data obtained on the physical properties of β mercury are given in a comparison with α mercury and tantalum. The data include precise critical field measurements at 0 pressure, as well as the change in critical field for a given temperature with pressures up to 3000 atm. The data are analyzed thermodynamically and discussed. (T.R.H.)

13537 TRANSPORT PROPERTIES OF LIQUID HELIUM. J. R. Pellam (California Inst. of Tech., Pasadena). p.424-38 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A review is presented of papers on rotating He II. The first experiment discussed is the effect of channel geometry and rotation on the critical heat current in liquid He II. Then the discussion moves to energy per unit length of the free vortex line in He II, vorticity in He II, evidence of the

nature of rotating liquid helium, torsional rigidity of rotating He II, hydrodynamics of liquid He II, and oscillating processes in rotating He II. (T.R.H.)

13538 THE KAPITZA RESISTANCE. L. J. Challis (Univ. of Nottingham, Eng.). p.466-76 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A review is presented of Kapitza's work, his first studies and including the work described in the four papers presented in the present conference. (T.R.H.)

13539 THE HEAT FLOW BETWEEN METALS AND LIQUID HELIUM II. L. J. Challis (Univ. of Nottingham, Eng.). p.476-80 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A preliminary study of the dependence of the Kipitza resistance on the state of the metal is offered. Four experiments were made: Kapitza resistance vs. temperature of cold-worked copper before and after annealing; Kapitza resistance of lead vs. purity in a magnetic field of 800 gauss; Kapitza resistance of lead in normal and superconducting state; and Kapitza resistance and thermal conductivity of lead at 1.7°K in transverse magnetic fields from 1000 to 3700 gauss. (T.R.H.)

13540 THEORY OF KAPITZA'S TEMPERATURE GAP AT THE BOUNDARY OF A SOLID BODY AND LIQUID HE^3. I. L. Bekarevich and I. M. Khalatnikov (Inst. for Physical Problems, Academy of Sciences, Moscow). p.480-2 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 9626.

13541 THE KAPITZA RESISTANCE. W. A. Little (Stanford Univ., Calif.). p.482-3 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A reexamination and extension of the theory of Khalatnikov, JETP 22: 687(1952), is offered. The modes of vibration of a semi-infinite elastic body are considered, and it is found that the surface waves form one class of the normal modes. The epiphonons are not involved in the energy transfer. The heat transfer from the phonon to the epiphonon modes is calculated. The scattering by static imperfections of the surface disturbance created by the totally reflected phonons is considered. (T.R.H.)

13542 ON THE MEASUREMENT OF THERMAL CONDUCTIVITY AND KAPITZA BOUNDARY RESISTANCE OF LIQUID He^3. J. Jeener and G. Seidel (Harvard Univ., Cambridge, Mass.). p.483-6 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

It is shown that Lee and Fairbank, Phys. Rev., 116: 1359 (1959), in calculating the conductivity and boundary resistance used unrealistic assumptions in that the boundary resistance between the wall and the liquid is neglected. The corrected temperature difference is offered. The heat transport problem is analyzed neglecting temperature gradients within the liquid perpendicular to the axis of the tube. A thermal conductivity (K_h) is calculated for He^3 at 0.25°K which is much larger than the Lee and Fairbank value. Thus at low temperatures K_h increases with decreasing temperature in agreement with theory and what would be expected from viscosity and diffusion coefficient measurements. (T.R.H.)

13543 IONS IN LIQUID HELIUM. Lothar Meyer (Univ. of Chicago). p.487-95 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The problem of ions in liquid helium is reviewed, including eight papers of the present conference. The results of studies of low-field mobility of ions in helium are discussed first, followed by high-field studies and studies of the nature of the ions. (T.R.H.)

13544 INJECTION AND MOBILITY OF PHOTOELECTRONS IN LIQUID HELIUM II. A. Dahm, J. Levine, J. Penley, and T. M. Sanders, Jr. (Univ. of Minnesota, Minneapolis). p.495-7 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The successful injection into He II of external photoelectrons is reported, and a preliminary study of the mobility of these electrons is offered. Electrons were ejected from a planar photocathode immersed in liquid helium, and the time required for the injected charges to drift to a collector plate in a known electric field was measured. Observations were made between 1.1°K and the λ point. A consistent account of the data can be given by assuming that the elementary scattering process limiting electron motion is electron-roton scattering. The mobility is field dependent at the lowest and highest temperatures studied, this effect being ascribed to the presence of a second sound pulse produced by the absorption of light in the photocathode. (T.R.H.)

13545 IONIC MOBILITIES IN LIQUID HELIUM II. G. Careri, S. Cunsolo, and F. Dupré (Università, Padua). p.498-500 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Two new techniques for measuring mobilities in different conditions of temperature and external field are offered. The first consists of the measurement of the spreading of an ion beam due to the space charge. Then, when the total current carried by the beam is known, the density and mobility of the charges can be calculated if the space charge field is considerably lower than the externally applied field. The second procedure is an application of the magnetic deflection method introduced by Townsend to detect ionic mobilities in gases and which is now well known in solid-state physics as the Hall effect. The deflection angle θ of an ionic beam due to a magnetic field of B gauss is known to be $\tan \theta = \mu B 10^{-8}$, which, knowing θ and B, permits mobility to be evaluated. The method works for $\mu \sim 10^3$ cm^2/volt sec or larger when the shutter method becomes difficult. (T.R.H.)

13546 IONS IN THE TURBULENT FLOW OF LIQUID HELIUM-4. G. Careri, F. Scaramuzzi, and W. D. McCormick (Università, Padua). p.502-5 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The mobility of negative ions in liquid helium is reduced by turbulence. This effect has been used to study the critical velocity for the production of turbulence in a relatively wide channel of rectangular cross section. (T.R.H.)

13547 IONIC RECOMBINATION IN LIQUID HELIUM. G. Careri and F. S. Gaeta (Università, Padua). p.505-8 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The volume recombination coefficient of ions in liquid He-II was measured by a simple and direct method, which is made possible by the fact that the range of α particles in the liquid is extremely small (about 0.2mm). The apparatus is essentially a system of two beams of ions of opposite sign, the current of which may be measured separately and then again when the two beams are superimposed. In the latter case, the total current J_T is obviously related to the recombination process in the overlapped beams. A simple analysis shows that if J_1 and J_2 are the currents of the two separate beams, E the applied field, S the area of the polonium source, e the electronic charge, and μ the ionic mobility, then $\alpha = (J_1 + J_2 - J_T)$ $8e\,E^2\mu + \mu - /J_1J_2$. (T.R.H.)

13548 THE INFLUENCE OF He^3 ON FILM FLOW. C. J. N. van den Meydenberg and K. W. Taconis (Kamerlingh Onnes Laboratorium, Leiden). p.530-2 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A study was made of the isothermal flow of the helium film in contact with liquid mixtures of He^3 and He^4. A mixture of low concentration is condensed in a lower vessel, Q, and separated from an upper vessel, P, by a superleak. The upper vessel contains a mixture of higher concentration, causing an osmotic pressure difference across the superleak. This gives rise to a superfluid flow of He^4 through the film along the inside wall of Q until equilibrium between P and Q is reached. The transfer rate varies continuously with concentration in Q and does not depend on the concentration in P. The rate depends on the path length of the film in Q. Variation of the transfer rate with height depends on both temperature and concentration in the case of mixtures. (T.R.H.)

13549 MODES OF ATOMIC MOTIONS IN LIQUID HELIUM IN INELASTIC SCATTERING OF NEUTRONS. D. G. Henshaw and A. D. B. Woods (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.539-44 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The change in wavelength of 4.039-A neutrons scattered inelastically from liquid helium at 1.12°K was measured at 30 angles of scattering in the range 10 to 140° for the liquid under its normal vapor pressure and at 25.3 atm. The dispersion curves obtained are given. Each curve is similar to that predicted theoretically for momenta up to 2.4 A^{-1}. At larger momenta the curves bend, suggesting a second maximum. The wavelength distribution of neutrons scattered through 80° from liquid helium was measured at 13 temperatures from 1.78 to 4.2°K. There is a marked theoretically unpredicted change in slope at the λ temperature and only a small decrease in this energy at temperatures above the λ point to 5.0°K at 4.2°K. The width of the spectrum increases rapidly from 2.5°K at 1.78°K to about 11.0°K at the λ temperature. The widths also show a marked theoretically unpredicted change in slope at the λ temperature above which there is only a slight further increase to 15.0°K at 4.2°K. (T.R.H.)

13550 ON PERSISTENT CURRENTS IN SUPERFLUID HELIUM. Philip J. Bendt (Los Alamos Scientific Lab., N. Mex.). p.576-8 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

An experiment was performed to measure directly the macroscopic persistent currents in an annulus filled with helium II, after the rotation has stopped. The experiment made use of the fact that there is a critical velocity above which a mutual friction between superfluid and normal fluid exists. Two minutes after rotation of the annulus stopped, about 10% of the initial angular momentum in the superfluid was collected in about 30 sec by vanes lowered into the annulus. Response of the vanes was immediate. After waiting 5 min, about the same amount of angular momentum was collected in 60 to 90 sec after a delay in response of 50 sec. The lifetime of the currents has not been measured. (T.R.H.)

13551 LIQUID AND SOLID HELIUM-3. William M. Fairbank (Stanford Univ., Calif.). p.583-604 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A review is presented of the properties of liquid and solid He^3, including those discussed in nine of the papers of the present conference. (46 references). (T.R.H.)

13552 NUCLEAR SUSCEPTIBILITY OF LIQUID He^3. H. A. Schwettman and H. E. Rorschach, Jr. (Rice Inst., Houston, Tex.). p.604-5 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The technique of adiabatic fast passage was used to measure the nuclear susceptibility of liquid He^3. Preliminary measurements at 18 cm Hg extend from 1.2 to 2.1°K. The sample contained 10% He^4. This method gives only relative values. These preliminary results indicate that the tendency toward higher degeneracy temperatures with decreasing He^3 densities extends to solutions of small He^4 content. (T.R.H.)

13553 THE COEFFICIENT OF EXPANSION OF LIQUID He^3. Eugene C. Kerr and R. Dean Taylor (Los Alamos Scientific Lab., N. Mex.). p.605-8 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Earlier direct observations of the density maximum in the coefficient of expansion of He^3 using an immersed glass pycnometer have been found to be erroneous below 0.7°K. The measurements have been refined and extended using a filled copper pycnometer with an attached capillary. Seventy-five density determinations over the range 0.30 to 1.8°K were fitted by least squares to the molar volume as a power series in the temperature. The smooth curve is given by $V_m(cm^3\ mole^{-1}) = 36.9087 - 0.7880T + 8375T^2 - 0.1175T^3 + 0.0604T^4$. The standard deviation is 0.011%, and the maximum deviation is 0.046%. The minimum in molar volume, 36.713 $cm^3\ mole^{-1}$, occurs at 0.506°K. (T.R.H.)

13554 ALIGNED ORBITAL ANGULAR MOMENTUM IN THE PROPOSED LOW TEMPERATURE PHASE OF LIQUID He^3. P. W. Anderson (Bell Telephone Labs., Murray Hill, N. J.) and P. Morel. p.608-10 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

It has been proposed that liquid He^3 undergoes a transi-

tion between 0.01 and 0.1°K. If liquid He^3 acts like a Fermi gas at such low temperatures, the attractive forces between atoms can cause a condensation into a lower energy state with correlations between pairs with equal and opposite momenta. The major difference from the superconducting ground state is that the pairs condense in states which have orbital angular momentum quantum number 2. As a result the energy gap is dependent upon the angle between k and some arbitrary direction in space, vanishing in some directions, so that there is not a true gap, but only a lowered density of states. It is also found that the lowest state is one in which there is a circulation about each He^3 atom, which may manifest itself in a surface current equivalent to a net total angular momentum per unit volume. Some new aspects of these results are discussed briefly. (T.R.H.)

13555 THE MELTING CURVE OF He^3. D. O. Edwards, J. L. Baum, D. F. Brewer, J. G. Daunt, and A. S. McWilliams (Ohio State Univ., Columbus). p.610-13 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The melting curve of pure He^3 was measured between 0.06 and 0.7°K by observing the pressure and temperature of a constant volume containing the liquid and solid phases in equilibrium. The apparatus used is described in some detail. The data, including values down to 0.12°K from a previous report, are plotted and compared with those of other workers. The calculated entropy of the solid at melting is constant at 1.26 cal/mole over the range 0.07 to 0.7°K. This is about 9% below the value of R1n2. It seems likely from the data that the transition temperature for the antiferromagnetism is less than 0.1°K. This is supported by the absence of a maximum in the melting curve. (T.R.H.)

13556 PVT ANOMALIES IN He^3 NEAR ITS MELTING CURVE. R. L. Mills, S. G. Sydoriak, and E. R. Grilly (Los Alamos Scientific Lab., N. Mex.). p.613-17 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Measurements of the PVT melting properties of high-purity He^3 have been extended down to 0.3°K. Because of the minimum (P_{min}) in the melting curve at $T_{min} = 0.32$°K, a special apparatus was required to transmit pressures below T_{min}. This apparatus is described. The melting curve obtained corresponds to the equation $P_m = 28.91 + 32.2 (T - 0.330)^2$ atm. The volume change also is plotted. A table is given showing smoothed values of the various melting properties for He^3 at even temperature intervals from T_{min} up to 1.2°K. (T.R.H.)

13557 PROPOSAL FOR A NEW He^3 VAPOUR PRESSURE SCALE. S. G. Sydoriak, T. R. Roberts, and R. H. Sherman (Los Alamos Scientific Lab., N. Mex.). p.717-20 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A new temperature scale is proposed which is to be arrived at by a procedure similar to that used for the existing T_E and T_L scales except for the use of actual specific-heat data. In addition, a different magnetic temperature conversion is being studied. A T_A scale (provisional for magnetic calibrations), a T_B thermodynamic scale below 2.0°K, and a T_C full-range equation scale are discussed. (T.R.H.)

13558 A DEVICE FOR PRODUCING ENERGETIC IONS. (to U. S. Atomic Energy Commission). British Patent 862,835. Mar. 15, 1961.

An arc discharge device for producing energetic ions is described in which electrons transfer their energy to ions. The device comprises a vacuum chamber in which a magnetic field is established and a gas-fed arc discharge is initiated with its axis parallel to the magnetic field. Time-varying electric fields are induced in the volume surrounding the discharge by pressure gradients so that a portion of the electrons in the discharge are accelerated and thereby transfer their energy to ions in the volume. (D.L.C.)

Astrophysics and Cosmology

13559 THE ABUNDANCES OF THE ELEMENTS IN THE SOLAR ATMOSPHERE. Leo Goldberg, Edith A. Müller, and Lawrence H. Aller (Univ. of Michigan Observatory, Ann Arbor). Astrophys. J., 5: Suppl. Ser., No. 45, 1-138 (Nov. 1960).

The method of weighting functions was utilized to derive the abundances of forty-two elements from faint and medium-strong lines in the solar spectrum. The model atmosphere adopted was that of Aller and Pierce as extended by Elste to both higher and deeper layers. The chief sources of equivalent widths were the measurements by Allen and by the Utrecht astronomers, but a substantial number of new measurements were included from McMath-Hulbert Observatory data. The f-values were taken from many different sources, but, whenever possible, experimental measurements were employed. When laboratory data were not available, they were replaced by theoretical values based on the assumption of LS coupling and making use of the f-sum rule or of the Bates and Damgaard tables for the absolute scale factor. A detailed description is given of the derivation of the abundance of each element, including the major sources of uncertainty, such as the errors in the measurement of weak lines throughout the spectrum and of all lines in the ultraviolet region, uncertainties in the solar model for ultraviolet lines, and the unreliable character of many of the f-values employed. (auth)

13560 THE ABUNDANCES OF THE ELEMENTS IN G-TYPE SUBDWARFS. Lawrence H. Aller (Univ. of Michigan Observatory, Ann Arbor) and Jesse L. Greenstein. Astrophys. J., 5: Suppl. Ser., No. 46, 139-86(Nov. 1960).

High-dispersion spectroscopic analyses were made of three G type and one A type subdwarfs. Because of the extreme weakness of the atomic lines, a large amount of observational material was collected for HD 19445 and HD 140283 (which has the highest weight); HD 219617, a star with intermediate line strengths was treated less elaborately, as was the high-velocity A star HD 161817. A table of wavelengths and identifications is given for HD 19445; equivalent widths are given for the stronger lines in all stars. The weakness of ionized metals makes it difficult to determine the temperature spectroscopically. Consequently, temperatures were based on the U, B, V photoelectric colors or the scanning of the continuous spectra, with corrections for blanketing by the lines, made by Melbourne. Not all subdwarfs are identical in composition. The average abundance of the metals, as compared with the sun was deficient by a factor of 40 in HD 19445, 100 in HD 140283, and 20 in HD 219617, whereas HD 161817 shows only small and uncertain deficiencies. The lines of CH were used to obtain an estimate of the carbon abundance, which was found to be very low in the G subdwarfs. There was some evidence for a greater than normal ratio of nickel/iron. The mean relative abundances of the elements from carbon to barium for the three G subdwarfs showed some apparently real differences from solar values. The

implications for theories of nucleogenesis are discussed. A rough analysis of the hydrogen-line profiles, based on the Kolb-Griem theory of line broadening, was satisfactory except for an indication that the cores are superposed on broad, nearly undetectable, wings. (auth)

13561 RELATIONSHIP BETWEEN CHARGED PARTICLE MEASUREMENTS MADE BY MEANS OF TRAPS ON SOVIET SPACE ROCKETS AND EXPLORER-VI AND PIONEER-V DATA ON MAGNETIC FIELD. K. I. Gringauz and S. M. Rytov. Doklady Akad. Nauk S.S.S.R., 135: 48-51 (Nov. 1, 1960). (In Russian)

Data produced by trielectrode traps on Soviet rockets and magnetometers on Explorer VI and Pioneer V were correlated and verified by various methods. The results show good agreement and indicate that the "current ring" discovered by magnetic measurements is a drift current caused by geomagnetic-field heterogeneity at an elevation of ~60000 km in the outermost charged particle belt. (R.V.J.)

13562 ON MAGNETIC HYDRODYNAMICS IN THE IONOSPHERE. E. A. Novikov (Inst. of Aerophysics, The Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz., 1624-34(Nov. 1960). (In Russian)

A system of equations was derived for ionospheric magnetohydrodynamics, considering anisotropy in the approximation of nonvortex electrical fields. Electromagnetic fields, currents, polarized charges, electromagnetic force, and electromagnetic energy dissipation which accompany the turbulent motion of gas in the atmosphere were investigated. Effective conductivity coefficients describing the turbulent flow of anisotropically conducting gas are introduced, and the influence of the earth's magnetic field on turbulent gas motion in various layers of the ionosphere is evaluated. (tr-auth)

13563 POSSIBLE METHODS FOR DETECTING INTERGALACTIC HYDROGEN. Satio Hayakawa (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 24: 1131-2(Nov. 1960). (In English)

Methods are proposed for measurement of the particle density of intergalactic hydrogen. It is suggested that the band spectrum from the transition $2S \rightarrow 1S + 2h\nu$ be employed in the measurements because of its relatively large optical depth. The practicality of observation of proton-antiproton and electron-negatron annihilation processes as a measuring device is also discussed. Limitations on the accuracy of these measurement methods are discussed. (T.F.H.)

Cosmic Radiation

13564 (AFCRC-TN-60-433) STANDARD ERRORS AT HARMONIC ANALYSIS. Eric Dyring and Bengt Rosen (Uppsala Univ. Inst. of Physics). Mar. 25, 1960. Contract AF61(514)-1312. 17p. (AD-243528)

Standard errors of harmonic analysis were calculated by three different methods. These methods are discussed and numerical calculations were carried out from the results of harmonic analyses made on data from the neutron monitors in Uppsala and Murchison Bay. Periods covering from single days up to the mean of three years were used for the comparison between the results. Although the standard error calculated according to the three methods include different types of variations, the results show good similarity. One of the methods also gives indications that only in some cases the addition of a second harmonic will be an improvement of the fit. (auth)

13565 (AFCRL-TN-60-699) THE 27-DAY RECURRENT VARIATIONS IN THE COSMIC-RAY INTENSITY. M. A. Shea and J. A. Lockwood (New Hampshire. Univ., Durham). [1960]. 45p.

An analysis was made of the 27-day recurrent variations in cosmic-ray intensity from 1954 to 1959 using data obtained from nucleonic detectors at Mount Washington and Durham, N. H. The relation between the planetary magnetic index, K_p, and the nucleonic intensity variations was studied. Periodicities ranging from 24 to 31 days found during this interval indicate that the intensity variations are not necessarily associated with the central meridian passage of active solar regions. No consistent change was found in the length of the period with respect to the solar activity cycle. (auth)

13566 (NP-9860) EXTENSIVE AIR SHOWERS OF THE COSMIC RADIATION. Final Report. John R. Green (New Mexico. Univ., Albuquerque). Jan. 16, 1961. Contract AF49-(638)-34. 64p.

A number of investigations were carried out on the structure, properties, and interactions of the components of extensive air showers. Two scintillators having an acceptance area of 7.3 m^2 were developed together with the circuits necessary to analyze and record the scintillator data. An automatic data-reduction system with considerable flexibility of function was designed to give the data in the form of punched cards. Three smaller scintillators with an area of 0.66 m^2 were also constructed. The size spectrum of extensive air showers in the region 10^4 to 10^8 particles was investigated and found to be represented by a power law of the form $K(\geq N) = (2.26 \pm 0.14) \times 10^{-7}(N/10^6)^{-(1.540 \pm 0.006)}$ $\cos^{6.5}$ $sec^{-1}m^{-2}str^{-1}$ at the elevation of Albuquerque (1575 msl). The results are of significance to theories regarding the origin of very energetic particles that produce the showers. A μ meson telescope was constructed from the three small scintillators with an 8-in. lead absorber. It was placed in operation for a period of 55 days to obtain barometric and temperature coefficients for the mu-mesons and to observe variations in the flux of these particles. The measurements were made during a period of solar activity, and the results indicate the desirability of continuing the measurements. A vertical telescope formed from the two larger scintillators with variable amounts of absorber (lead and water) between them was used to find the average energy of the electronic component as a function of distance from the shower core. The results indicate that at 3 to 30 m from the core of the extensive air showers the average energy of an electron decreases from 5×10^8 to 10^8 ev. In this range the dependency of the average electron energy on the distance from the core is well expressed by a power law: $r^{-0.7}$. This result, taken together with results of two other investigations at different elevations, indicates a change in distribution of electronic energies between mountain elevations and sea level. Generally, earlier experiments on the lateral distribution of particle densities indicated no essential change in the lower third of the atmosphere; however, some indications that there could be small but important structural changes were present. The present results lend support to the latter indications. A new transition effect for the showers with water as an absorber was obtained. The transition curves made it possible to estimate that the relative number of photons to electrons is not far from unity and that the ratio of the average photon energy to the average electron energy varies from about 2 to 5 near the periphery of the shower to approximately unity near the core. (auth)

13567 AN ATTEMPT TO DETECT LINEAR POLARIZATION IN THE GALACTIC BACKGROUND RADIATION AT

215 Mc/s. J. L. Pawsey and E. Harting (C.S.I.R.O., University Grounds, Chippendale, N. S. W.). Australian J. Phys., 13: 740-2(Dec. 1960).

A discussion is given of possible causes for galactic-polarized radiation. An attempt is reported to detect linear polarization in the galactic background. Observations are made at 215 Mc with bandwidths of 1000, 700, and 300 kc. The region observed is centered at 34°S and between 1 hr 30 min to 10 hr right ascension. The observations set an upper limit of 1% to linear polarization in the region of the sky observed. (T.F.H.)

13568 RADIATION MEASUREMENTS DURING THE FLIGHT OF THE THIRD SPACE ROCKET. S. N. Vernov, A. E. Chudakov, P. V. Vakulov, E. V. Gorchakov, Yu. I. Logachev, and A. G. Nikolaev. Doklady Akad. Nauk S.S.S.R., 136: 322-4(Jan. 11, 1961). (In Russian)

Preliminary data recorded by instruments on the third cosmic rocket, October 4 to 18, 1958, are presented. The first data were transmitted at elevations of 7500 to 14,000 km; the next data were transmitted at 130,000 km. Data on the outer radiation belt are tabulated. The intensity of cosmic radiation outside the influence of the magnetic field and the atmosphere was 2.12 counts/cm^2/sec, the mean pulse count at a threshold energy of 45 kev was 6.79 pulse/cm^2/sec, and at a threshold energy of 3.6 Mev it was 2.15 pulse/cm^2/sec. The mean ionization for the whole crystal was 1.56×10^9 ev/sec. The data transmitted during the first 14 days of flight indicate a constant radiation intensity beyond the earth's magnetic field. Some weak deviations from the "mean-intensity" were recorded in rare instances. These deviations are assumed to be related to magnetic field variations in the solar system and to the effects of these fields on the incoming cosmic-ray intensity. (R.V.J.)

13569 ON THE CHARGED PARTICLE ESCAPE FROM THE OUTER GEOMAGNETIC FIELD. V. D. Pletnev (Inst. of Astrophysics, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz., 1671-3(Nov. 1960). (In Russian)

The magnetic moment of each particle [$\mu = (mv^2/2H)$] qualifies the motion and concentration mechanism of particles trapped by a magnetic field. With a considerable change in μ, the particle escapes either into denser layers of the atmosphere or into outer space, thus shortening its life in the outer geomagnetic field. The magnitudes of $2\pi\rho/\lambda$ for protons and electrons at various distances from the earth's center are tabulated and analyzed. (R.V.J.)

13570 ON THE PROBLEM OF CORPUSCULAR RADIATION DISTRIBUTION IN THE EARTH'S STATIONARY MAGNETIC FIELD. V. D. Pletnev (Inst. of Geophysics, Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz., No. 1, 150-3(Jan. 1961). (In Russian)

The relative density of fast charged particles in a space without geomagnetic perturbations was calculated by using simplified Boltzmann equations. Calculations were also made of the anisotropic distribution of corpuscular radiation near the equator along magnetic-field lines. The data on corpuscular-radiation anisotropy allow a solution to the problem of relative distribution of corpuscular radiation along the magnetic lines and also to the absolute distribution in space. (R.V.J.)

13571 THE TOTAL ELECTRON CONTENT OF THE IONOSPHERE DURING THE MAGNETIC DISTURBANCE OF NOVEMBER 12-13, 1960. G. N. Taylor (Univ. of Manchester, Eng.). Nature, 189: 740-1(Mar. 4, 1961).

Measurements were made of the total electron content of the ionosphere during the magnetic disturbance of Nov. 12 and 13, 1960. The measurements were made by observation of the differential Faraday fading of lunar radio echoes on two closely spaced frequencies with equipment mounted on 250-ft Jodrell Bank radio telescope, which allows up to 16 hr continuous observations a day and gives reliable information on short-term and day-to-day variations in total electron content. Curves are presented which show total electron content at various times for each of the days from Nov. 11 through 14. The moon was at high enough elevation to permit careful observations during this period. The data indicate that apparently there was a scaling down of the whole ionosphere rather than a vertical redistribution of ionization within it. (C.H.)

Criticality Studies

13572 (BMI-1501) ML-1-1B CRITICAL-ASSEMBLY STUDIES. Joseph W. Ray, Richard G. Matthews, William S. Hogan, David A. Dingee, and Joel W. Chastain, Jr. (Battelle Memorial Inst., Columbus, Ohio). Feb. 21, 1961. Contract W-7405-eng-92. 76p.

Critical-assembly studies were conducted to provide physics and engineering data to aid in the development of the Mobile Low-power Reactor (ML-1-1B). The ML-1-1B critical assembly is a multitube assembly consisting of pin type fuel elements within a radial lead reflector. The elements are 19-pin assemblies contained in an insulation liner and a pressure tube, with steel-shim poison and cadmium–copper burnable-poison bands present on the insulation liner. The ML-1-1B core without steel-shim poison was critical with 48 elements containing 31,088.36 g of U^{235} with an excess reactivity of 0.746×10^{-2} $\Delta k/k$ at a moderator temperature of 23.00°C. The core with the steel-shim poison was critical with 51 elements containing 32,999.97 g of U^{235}, with an excess reactivity of 0.418×10^{-2} $\Delta k/k$ at a moderator temperature of 23.00°C. The ratio of maximum element power to core-averaged radial power was approximately 1.32. The ratio of maximum to core-averaged radial thermal flux was approximately 1.35. The maximum shutdown worth of a reference control-blade mock-up was 1.79×10^{-2} $\Delta k/k$, and of a stainless-steel-regulating control-blade mock-up was 0.59×10^{-2} $\Delta k/k$. The fuel tubes were filled with water to simulate flooding the core. In this condition the core was critical with 42 elements containing 27,221.00 g of U^{235} with an excess reactivity of 0.436×10^{-2} $\Delta k/k$ at a moderator temperature of 23.00°C. With a set of five mock-up control blades and one shim blade, the flooded core was critical with 61 fuel elements with an excess reactivity of 0.436×10^{-2} $\Delta k/k$. A concentration of 56.8 mg of natural boron per liter of moderator was found to correspond to a shutdown reactivity worth of 1.0×10^{-2} $\Delta k/k$. (auth)

13573 (CEND-94) STUDY OF SLIGHTLY-ENRICHED URANIUM-WATER LATTICES WITH HIGH CONVERSION RATIO. Quarterly Progress Report, November 1, 1959 to January 31, 1960. An IBM-704 Program for Calculating Effective Resonance Absorption Cross Sections by the Narrow Resonance or Narrow-Resonance-Infinite Mass Approximation. (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). 23p. Contract AT(30-1)-2379.

The computer program, which was developed for the calculation of resonance integrals, is essentially the same as a program for calculating of the resonance integral of an isolated lump. The effective chord length to be used is input to the computer program, where the input quantity $\bar{r}$ is the effective average chord length. The equivalence between a lattice and some isolated lump allows the use of

the tables of functions prepared by Adler, Hinman, and Nordheim for making lattice calculations. The QUERY computer program for calculating the resonance integral caused by resolved resonances is primarily an interpolation routine for using the tables. For the unresolved resonance range the QUERY program uses the Adler-Hinman-Nordheim tables but carries out two integrations. One integration is over a Porter-Thomas distribution of neutron widths. The second is an integration over an arbitrary energy range. (auth)

13574 (GEAP-3574(Rev.)) ANALYTICAL METHODS FOR CONSUMERS RESEARCH AND DEVELOPMENT PHYSICS. M. L. Couchman and C. L. Miller (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 24, 1961. Contract AT(04-3)-361. 18p.

A method is described which involves application of several computer codes to calculate effective three-group cross sections and to perform the cell or core diffusion calculation required to obtain reactivity and power distribution. Epithermally, a 54-group scheme is used in which corrections for fast fission and absorptions in U^{238} are applied separately. In the thermal group, the Wilkins heavy gas model is used, combined with flux depression factors from a transport approximation calculation. The methods were applied to six of the Savannah uniform critical assemblies and one of the nonuniform assemblies. In the case of the uniform criticals, the discrepancy between measured and calculated reactivity was always less than 1% k_{eff}. Three different water-to-fuel ratios were included in the study. In the case of the single nonuniform critical, the calculated k_{eff} was only 0.5% higher than the measured value. (auth)

13575 (HW-67179) MEASUREMENTS OF NEGATIVE k_{ex} FOR A GRAPHITE URANIUM LATTICE IN THE PCTR. E. Z. Block and D. E. Wood (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1, 1960. Contract AT(45-1)-1350. 24p.

The values of k_∞ and f were measured for a cluster fuel element in a 7-in. graphite lattice. The value of k_{ex} was negative for natural uranium fuel; so two methods of measurement were compared: (1) the normal method of poisoning the lattice with thin strips of copper with an extrapolation of the result back to a k_∞ of one and (2) producing the condition of unit k_∞ by adding to the cell U^{235} as thin strips of U^{235}-aluminum alloy. A measurement was made for a slightly enriched fuel in the same geometry, with k_{ex} positive, to provide a check on the other methods used. The measured values of k_∞ agreed within the quoted error. The values of k_∞ and f are, respectively, 0.944 and 0.907 as measured by adding U^{235} to the cell containing natural uranium fuel. (auth)

13576 (HW-67691) LEAKAGE OF NEUTRONS FROM BARE SUBCRITICAL PLUTONIUM SYSTEMS. B. C. Clark and J. L. Carter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 5, 1960. Contract AT(45-1)-1350. 20p.

Results are given of approximate calculations of the total leakage rate of fast and thermal neutrons from bare subcritical systems of plutonium in solution. These calculations are of use in assessing the possibility of monitoring this leakage for nuclear safety purposes. The calculations are based on a simple one-group model with slowing down, assuming pure Pu^{239} as the fuel. Parameters in the model are adjusted to agree with the best available information on the critical volumes of such solutions. Corrections are made to estimate the effect of small amounts of Pu^{240}. The concentrations encountered in the calculations ranged from 25 g/l to 1000 g/l, corresponding to H/Pu atomic ratios from 20 to 1000. The results for pure Pu^{239} fuel can be summarized as follows: Both the fast and thermal leakages from systems of a given concentration are predicted to increase by about a factor of 10 as the volumes change from 0.5 to 0.9 of critical volume. For a fixed volume, the change in leakage with concentration change is a more complex function of concentration and volume. For the volumes considered, the leakage of fast neutrons from solution concentrations which are 0.9 that of critical range from 4 to 18 times the leakage from concentrations which are 0.5 that of critical. The corresponding thermal leakage ratios for each volume are about one-half as large as the fast neutrons. The presence of Pu^{240} decreases these ratios by an appreciable factor in some cases. (auth)

Elementary Particles and Radiations

13577 (CERN-61-3) SEPARATION OF HIGH-ENERGY PARTICLES BY MEANS OF STRONG INTERACTION PROCESSES. G. Goldhaber, S. Goldhaber, and B. Peters (European Council for Nuclear Research, Geneva). Jan. 27, 1961. 18p.

Studies of strongly interacting particles in the Bev region produced experimental results which can be extrapolated to 10 Bev. These results indicate that there are many interactions in which a particle, belonging to the same isotopic multiplet and carrying the same baryon number as the incident particle, emerges within a narrow cone around the forward direction with a large share of the available energy. In collisions between high-energy π-mesons with nucleons, a baryon is emitted in the backward hemisphere in the center-of-mass system. Applications of these two experimental results to obtain enriched antineutron, antiproton and positive K-meson beams are discussed. (J.R.D.)

13578 (NP-9644) ON THE INTRINSIC PAULI PRINCIPLE. W. Królikowski (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). Mar. 1960. 5p. (PAN-141/VII)

It is pointed out that the absence of higher spins and multiple charges for elementary particles may be a consequence of a fundamental principle which plays a role similar to that of Pauli principle in atomic physics. A realization of such an "intrinsic Pauli principle" for isotropic properties of elementary particles is given. (auth)

13579 (NP-9867(p.27-9)) USE OF PHOTOPRODUCTION EXPERIMENTS TO DETERMINE Y-K RELATIVE PARITIES. I. Manning (Naval Research Lab., Washington, D. C.).

It is shown that the reaction $\gamma + p \rightarrow Y + K$ is capable of giving an unambiguous determination of the Y-K relative parity if it is carried out with linearly polarized photons. (D.L.C.)

13580 (NP-9901) THE MANY BODY PROBLEM. Physics Monographs No. 6. C. N. Yang (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). 1960. 91p.

Lectures at the Latin American School of Physics, June 27–August 7, 1960.

The many-body problem is treated generally, and applications are made for Bose and Fermi systems. Dense hard and soft spheres are also considered. Thermodynamics and superfluidity are discussed. A grand partition function is derived. (D.L.C.)

13581 (NYO-9543) THE NON-LINEAR THEORY OF ELEMENTARY PARTICLES. Discussions led by W. Hei-

senberg (Rochester, N. Y. Univ.). Feb. 27, 1961. Contract AT(30-1)-875. 42p.

A transcript is given of a recorded discussion of the nonlinear theory of elementary particles; which was held at the University of Rochester in August 1960, at the close of a seminar on "Theories of Elementary Particles." (B.O.G.)

13582 (TID-11553) REPRESENTATION OF ANGULAR DISTRIBUTION DATA BY A LEGENDRE POLYNOMIAL EXPANSION. T. J. Kostigen (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Sept. 1, 1960. Contracts AF33(600)-38062 and AT(11-1)-171. 13p. (XDC-60-12-58)

Transformation matrices are presented for use in fitting angular distribution data in terms of a Legendre polynomial expansion. These matrices are computed by a FORTRAN II program for the situations when the experimental data can be adequately represented by eleven or twenty-one points. A listing of the FORTRAN-II program is included. (auth)

13583 (TID-11564) PRODUCTION CROSS SECTIONS FOR GAMMA RAYS (PROGRAM GAMMA-P). Mary S. Ferry (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Aug. 17, 1960. Contracts AF33(600)-38062 and AT(11-1)-171. 79p. (XDC 60-11-138)

The cross section for the production of γ rays by radiative capture of a neutron, by inelastic scattering of a neutron, and by neutron-induced fissioning is computed by Program GAMMA-P as a function of the neutron lethargy and the photon energy bands. Neutron cross sections and γ spectra for all three reactions are input for the program. Corrections are made for discrepancies between the neutron binding energy and the energy-integrated γ spectrum of the element or isotope, for the neutron kinetic energy, and for internal conversion. Gamma production cross sections computed by Program GAMMA-P are being used with transport theory program S-VII and are to be included on the Reactor Nuclear Data Tape. The production cross sections are automatically punched on decimal cards for ease of use with other programs. A tabulation of γ ray production cross sections for 21 elements is included. (auth)

13584 (UCRL-9489) S- AND P-WAVE INTERACTIONS OF K^- MESONS IN HYDROGEN (thesis). Paul Nordin, Jr. (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 21, 1960. Contract W-7405-eng-48. 40p.

The experimental study of low-energy K^--meson interactions in a hydrogen bubble chamber is continued and the energy range extended to a region that involves P waves. Scattering and hyperon-production cross sections are measured at mean K^--meson laboratory momenta of 300 and 400 Mev/c. Elastic-scattering angular distributions are obtained and, along with the values of the cross sections, indicate the presence of P waves. Based on 289 observed decays, the measured K^--meson lifetime is $1.31 \pm 0.08 \times 10^{-8}$ sec. (auth)

13585 (NP-tr-561) L'EFFET COMPTON ET LES LIMITES D'APPLICABILITE DE L'ELECTRODYNAMIQUE QUANTIQUE. (The Compton Effect and its Limits of Applicability in Quantum Electrodynamics). V. A. Petukhov, A. A. Komar, and M. N. Yakimenko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy and Akademiya Nauk S.S.S.R. Institut Fiziki im. P. N. Lebedeva). Translated into French by N. Mouravieff from Report JINR-P-283, Mar. 1959. 24p.

It is shown that it is possible in principle to do an experiment on the Compton effect at 660 Mev with a precision of about 2%. This precision is obtained by the method of double ratios since the errors of the experiment (determination of energies, angles, etc.) appear with factors noticeably lower than unity. The conditions are determined in which these factors take their minimum values. The various perturbating effects are analyzed, and means of opposing them are discussed. The precision allows determination of the elementary length of 3×10^{-14} cm by the experimental method. (tr-auth)

13586 EXPERIMENTAL STUDY OF INTEGRATED ABSOLUTE REFLECTION OF X RAYS BY TRANSMISSION. Andre Authier (Faculte des Sciences, Paris). Acta Cryst., 14: 287-91(Mar. 10, 1961). (In French)

An experimental study of the integrated intensities and the rocking curves for beams having undergone the anomalous transmission of x-rays were made for several thicknesses of the sample with a double crystal spectrograph. Absolute measurements were made with an ionization chamber on nearly perfect silicon crystals. The results are in good agreement with those of the dynamical theory. (auth)

13587 CENTRAL SCATTERING OF X RAYS BY FILIFORM PARTICLES. V. Luzzati and H. Benoit (Centre de Recherches sur les Macromolecules, Strasbourg). Acta Cryst., 14: 297-300(Mar. 10, 1961). (In French)

The asymptotic form of the intensity scattered by an assembly of filiform particles is determined for large values of s and the geometrical parameters it depends on are given. The influence of certain types of configuration on this asymptotic behavior is discussed. (auth)

13588 ON THE NEUTRAL DECAY PRODUCTS OF MUONS. P. Vertes (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 12: 249-52(1960). (In English)

Several experiments are proposed for detection of the neutrino (ν) thought to be emitted in the μ-meson decay reaction $\mu^{\pm} \rightarrow e^{\pm} + \nu + \bar{\nu}$, in which $\bar{\nu}$ is the antineutrino. Reactions and interactions of ν are discussed for such cases as μ-meson–nuclei interactions and μ-mesic atom decay. (T.F.H.)

13589 ABSORPTION OF HIGH ENERGY NEUTRINOS. G. Marx and M. Elkishem (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 12: 257-62(1960). (In English)

The postulation of the existence of two types of neutrinos is found to expedite the theory of weak interactions. High-energy weak interactions between neutrinos and baryons and leptons are studied. In the neutrino energy range 10 to 100 Bev, allowed and forbidden neutrino–electron and neutrino–nucleon weak absorption reactions are studied. The dependence of the cross sections of these reactions on neutrino energy is discussed, and the difficulty of detecting the reactions is shown. (T.F.H.)

13590 SOME OF THE DIFFICULTIES OF THE DYNAMIC THEORY OF ELECTRONS. A FORMALISM WHICH ATTEMPTS TO COUNTER THEM. M. Tournarie (Centre d'Études Nucléaires, Saclay, France). Bull. soc. franc. mineral et crist., 83: 179-86(1960). (In French). (CEA-1694)

Among the difficulties encountered in the dynamic theory of electrons are those of expressing the boundary conditions, a workable formalism, and a solution sufficiently close to reality. In the case of transmission through a crystalline platelet, the difficulties were reduced by using a matrix representation in mixed space, direct in the direction of propagation and reciprocal in the two others. It was thus possible to obtain a few rigorous solutions and to compare them with those given in the same case by other theories. (auth)

13591 ON THE DISTRIBUTION OF LUMINESCENCE PHOTONS EMITTED ALONG THE PATH OF α PARTICLES

IN GASES. Maurice Duquesne and Irene Kaplan. Compt. Rend., 252: 102-3(Jan. 4, 1961). (In French)

The distribution of the total number of photons N_0 emitted along the trajectory of an α particle in nitrogen was studied by integral methods at various pressures below atmospheric. A direct measurement was made of $dN_0/dx = f(x)$. The experimental apparatus used is sketched. The distribution has the form of a Bragg curve, and the total number of photons emitted increases as pressure decreases. (J.S.R.)

13592 ELECTRODYNAMIC CORRECTIONS TO MAGNETIC MOMENT OF ELECTRON. P. Smrz (Faculty of Nuclear and Technical Physics, Prague) and I. Ulehla. Czechoslov. J. Phys., 10: 966-8(1960). (In English)

Values obtained for fourth-order corrections to the magnetic moment of the electron were compared and recalculated. The regularization for small momenta was modified so that each diverging integral was regularized by expanding the denominator by an infinitely small part. The value obtained for the magnetic moment, $\mu = \mu_0 (1 + \alpha/2\pi - 0.328\ \alpha^2/\pi^2)$, agreed with that of Petermann. (M.C.G.)

13593 ANALYSIS OF SOME INELASTIC p–n INTERACTIONS AT 9 Bev. Zh. S. Takibaev, V. A. Botvin, and I. Ya. Chasnikov. Doklady Akad. Nauk S.S.S.R., 135: 571-2(Nov. 21, 1960). (In Russian)

Inelastic p-n interactions recorded in emulsion irradiated by a proton beam were analyzed for the purpose of identifying secondary charged particles. The largest angular asymmetry was previously observed in the distribution of secondary charged particles from three-prong interactions. The characteristics of the asymmetry are described. Secondary charged particles were identified in 22 out of 72 recorded three-prong events. The angular distribution of the secondary charged particles in the center of mass system indicates a noticeable forward asymmetry. The magnitude of the asymmetry, determined by the ratio $\Delta = \Sigma(n_f - n_b)/N$ (where the n_f and n_b are the number of particles emitted forward and backward in the center of mass system; N is the number of interactions), is 0.55 ± 0.24, which is smaller than the magnitude quoted in the literature. The plotted angular distribution of protons and mesons in the center of mass system is nearly symmetric for protons, while for π mesons it is asymmetric. This contradicts a previous postulation on the influence of protons on the angular asymmetry of secondary charged particles in p-n interactions. The mean proton and π-meson energies were found to be $\overline{E}_p = 1.303 \pm 0.043$ and $\overline{E}_\pi = 0.436 \pm 0.030$ Bev; the mean magnitude of transverse pulses for protons and π mesons was $\overline{P}_p = 0.244 \pm 0.032$ Bev/c and $P_\pi = 0.158 \pm 0.022$ Bev/c. (R.V.J.)

13594 MEASUREMENTS OF ANGULAR DISTRIBUTION IN WILSON CHAMBER. F. R. Arutyunyan (Inst. of Physics, the Academy of Sciences, Armenian SSR). Izvest. Akad. Nauk Armyan. S.S.R., Ser. Fiz.-Mat. Nauk, 12: No. 4, 121-5(1959). (In Russian)

The angular projection on the photographed plane and the angular projection on the plane passing through the initial trajectory are equal in cases where the trajectory before the scattering is parallel to the photographed plane. Two events of angular distribution distortions are analyzed. The first case concerns the point where the initial trajectory forms an arbitrary angle γ with the photographed plane and enters vertically into multiplate Wilson chamber due to particle scattering in the preceding plates. This results in a larger angle on the photoplate than the angle projected on the plane passing through the initial trajectory. In the case where the particle passes the side of the chamber at a sufficiently large distance from the optical axis of the photo object (in comparison to the distance from the photo object to the scattering point inside the chamber), the angle of the true projection of scattering is larger due to the nonorthogonal projection of the angle of scattering on the photoplate. Corrections were made for the proton angle of scattering. (R.V.J.)

13595 ELECTRON ELASTIC SCATTERING WITH ORIENTED SPIN BY METAL CRYSTAL LATTICE. A. B. Kukanov (Moscow State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 10-20(1960). (In Russian)

Electron elastic scattering by metallic crystals was analyzed by relativistic quantum mechanics. A solution was derived for the Dirac equation based on almost free electrons in the crystal. Formulas connecting diffraction wave amplitudes with incident amplitudes are developed. Conditions for selective Wolf–Bragg reflection are found, and the problem of electron wave penetration of metals was resolved. (tr-auth)

13596 ELECTRON-POSITRON LONGITUDINAL POLARIZATION IN π^0 MESON DECAY. B. K. Kerimov, A. I. Mukhtarov, and S. A. Gadzhiev (Moscow State Univ. and Kirov Azerbaidzhan State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 26-30(1960). (In Russian)

The case of π^- charge-exchange scattering on hydrogen, $\pi^- + p \rightarrow \pi^0 + n$, followed by π^0-meson decay into $e^- + e^+ + \gamma$ was studied previously without considering the polarization properties of the particles. An attempt is made to analyze the decay process considering longitudinal spin polarization in the $e^- + e^+ + \gamma$ decay. A probability formula was developed for describing the angular and polarization correlation in the decay. The correlation offers information on the parity and spin of the π^0. (R.V.J.)

13597 APPLICATION OF EXPANSION METHODS TO ELASTIC SCATTERING OF SLOW ELECTRONS BY HEAVY ATOMS. V. D. Kamenetskii and B. M. Yavorskii (All-Union Correspondence Inst. of Textile and Light Industry, [USSR]). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 5, 26-34(1960). (In Russian)

The expansion method was applied in an investigation of slow electron elastic scattering on heavy atoms. The S, P, D, and F elastic-scattering cross sections for mercury and calcium were calculated without considering exchange, and the S cross section for scattering on mercury was calculated considering exchange. Drukarev integral equations were used to verify the calculations of S cross sections without exchange. The effects of certain selections of valence-electron wave functions or of an approximation describing interactions of incoming electron with atomic residue on the magnitudes of cross sections are analyzed. The cross sections are correlated with experimental data. The accuracy of wave functions obtained by the expansion method is verified. (tr-auth)

13598 ON ELASTIC SCATTERING OF ELECTRONS WITH ORIENTED SPIN IN METAL CRYSTAL LATTICE. A. B. Kukanov (Moscow State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 6, 3-12(1960). (In Russian)

Selective electron wave reflection from metallic crystals (Wolf-Bragg reflection) was studied by relativistic quantum mechanics. A relation was found between the polarization of the reflection wave and that of the incident wave. A condition by which electron polarization can be converted into transverse (longitudinal) polarization is indicated. (tr-auth)

13599 RADIATIVE DECAY OF $\pi^\pm$ MESON. A. I. Mukhtarov, R. G. Eilanbekov, and S. A. Gadzhiev (Kirov Azerbaidzhan State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 6, 142-6(1960). (In Russian)

An analysis is made of $\pi^{\pm} \rightarrow \mu^{\pm} + \nu + \gamma$ decay by the Dirac theory of particles with oriented spin and with consideration of μ-meson anomalous magnetic moment. Calculations are made of the polarization and angular distribution of decay products. (tr-auth)

13600 ACCELERATION OF DEUTERONS IN A SYNCHROTRON. H. R. Shaylor and P. D. Whitaker (Univ. of Birmingham, Eng.). Nature, 189: 741-2(Mar. 4, 1961).

Deuterium gas was supplied to the radio-frequency ion source of the synchrotron injector. With the same injection energy as for protons (460 kev) a beam was found to enter the synchrotron vacuum system and to circulate before acceleration at a magnetic field of $\sqrt{2}$ times the value for protons. This beam was carried to full energy (estimated from the magnetic field to be 642 ± 12 Mev for mass 2) by suitable adjustment of the radio-frequency function generator and was found to circulate at maximum field with a frequency 0.76 times that for protons. The beam was extracted from the synchrotron by the method normally used for protons and was found to have an intensity of 10^8 particles per pulse over an area of 12 cm^2 at a distance of 16 m from the extractor. The range of the beam in copper was measured to be 167 ± 3 g cm^{-2} which, allowing for 7-Mev energy loss in polythene and air in the beam path, corresponds to an energy of 640 ± 5 Mev, confirming that the particles accelerated were deuterons. No beam was accelerated when hydrogen gas was fed to the ion source with the radio-frequency generator set for deuterons. The identity of the accelerated particles was also confirmed in a preliminary experiment to measure the differential cross section for the elastic scattering of deuterons by protons. (auth)

13601 CONSERVATION OF μ^+-MESON POLARIZATION IN EMULSION WITH AID OF MAGNETIC FIELD. A. O. Waissenberg and V. A. Smirnitskii (Smirnitsky) (Experimental and Theoretical Physics Inst., Academy of Sciences, Moscow). Nuclear Phys., 23: 23-31(Feb. 1961). (In English)

The space-asymmetry coefficient in $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ decay is measured as a function of external magnetic field in the 0 to 17 kilogauss range. It is shown that this dependence can be explained by the Paschen-Bach effect for muonium and the assumption that there is additional polarization due to charge-exchange at the end of the μ-meson path or to exchange collisions after the μ-meson has stopped. The minimum value of the asymmetry coefficient for NIKFI-R emulsions is equal to -0.09 ± 0.01 (without a magnetic field); the maximum value is equal to -0.29 ± 0.01 (in a stong field). The 10% difference between the coefficients -0.29 ± 0.01 and -0.33 predicted by the V−A theory is far outside the limits of experimental errors. Among 340,000 $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ decays scanned, not a single decay is detected into three electrons corresponding to the schemes $\mu \rightarrow 3e$ or $\mu \rightarrow e + \nu + \overline{\nu} + \gamma$ with the internal conversion of a γ ray into an $e^+ - e^-$ pair. (auth)

13602 ON THE HARD CORE IN NUCLEAR FORCES. J. K. Perring and R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys., 23: 153-7(Feb. 1961). (In English)

Counter-examples are presented to the argument that static hard-core potentials cannot match observed $^1S_0$ scattering in certain respects. (auth)

13603 TWO PION ANNIHILATION OF A N−$\overline{N}$ PAIR. R. P. Saxena (Muslim Univ., Aligarh, India). Nuclear Phys., 23: 158-63(Feb. 1961). (In English)

The problem of double-pion annihilation of a nucleon-antinucleon pair is investigated with the help of new Tamm-Dancoff techniques. It is shown that the empirical selection rules given by Bethe and Hamilton follow automatically from the present formalism. Furthermore, the annihilation cross sections for various specific processes are calculated, and a limited effort is made to compare these results with those of the experiments. (auth)

13604 A NOTE ON PHOTO-MESSONS FROM DEUTERONS. V. Devanathan and G. Ramachandran (Univ. of Madras). Nuclear Phys., 23: 312-18(Feb. 1961). (In English)

The cross sections for the photo-production of positive pions from deuterons are worked out under impulse approximation using Chew-Low amplitude of photopion production from nucleons. The numerical results obtained are in reasonable agreement with experimental data. (auth)

13605 ON THE $\pi^- + p \rightarrow \Lambda^0 + K^0$ AMPLITUDE. R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuclear Phys., 23: 345-8(Feb. 1961). (In English)

Two ways to resolve a certain phase-ambiguity arising in the S + P wave analysis of $\pi^- + p \rightarrow \Lambda^0 + K^0$ reactions are pointed out. (auth)

13606 FERMIONS AND THE INTRINSIC PAULI PRINCIPLE. Wojciech Królikowski (Univ. of Warsaw and Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Nuclear Phys., 23: 53-61(1961). (In English)

An approach to the problem of classification of elementary fermions is summed up. A possible extension of the formalism is pointed out. Then, some so far undiscovered fermions ("hyperbaryons") are allowed, whereas in the primary formalism only the presently known ones appear (namely, leptons ν, ν', e^-, μ^- and baryons p, n, Λ, Σ^+, Σ^0, Σ^-, Ξ^0, Ξ^-, provided there are two types of neutrinos ν and ν'). (auth)

13607 MOTION OF AN IMPURITY PARTICLE IN A BOSON SUPERFLUID. M. Girardeau (Boeing Scientific Research Labs., Seattle). Phys. Fluids, 4: 279-91(Mar. 1961).

The problem of the low-lying spectrum of a system of many bosons and one impurity particle interacting by repulsive, central, two-body forces was treated by first eliminating the dynamical variables of the impurity in terms of an added effective boson-boson interaction and then treating the boson system by an extension of Bogolubov's method. In this way various physical properties of the clothed impurity particle, including its dispersion relation and effective mass, were obtained. Singularities associated with the onset of acoustical wave drag as the impurity speed reaches the speed of sound in the boson medium are predicted. The parameters measuring the smallness of the corrections to the preceding results are shown to be the dimensionless boson-boson interaction, the dimensionless boson-impurity interaction, and the boson-impurity mass ratio. The treatment was adapted to the case of hard spheres at low density by employing the Huang-Yang-Lee pseudopotential method; the results are valid if the dimensionless boson density and the boson-impurity mass ratio are small. The connection of the models treated with experimentally accessible results is discussed. (auth)

13608 NEUTRON-NEUTRON SCATTERING LENGTH. Kirk W. McVoy (Univ. of California, Livermore and Brandeis Univ., Waltham, Mass.). Phys. Rev., 121: 1401-10 (Mar. 1, 1961). (UCRL-6038)

The final-state interaction of the two neutrons from the reaction $\pi^- + d \rightarrow 2n + \gamma$ has a pronounced and distinctive effect on the momentum spectrum of the outgoing particles. In particular, the neutron spectrum is sharply peaked in the neighborhood of 2 Mev, with a shape that is quite sensitive to the strength of the nn interaction. In the region of this peak, the relative neutron-neutron momentum is so small that the nn interaction is completely characterized by its scattering length. Hence it is proposed that a measurement of the shape of the neutron spectrum from this reaction may provide a convenient means of measuring the neutron-neutron scattering length. Neutron spectra are calculated in an impulse approximation for several assumed values of the scattering length. It appears from their shapes that, in this way, present neutron-detection techniques should be capable of determining the scattering length to within 25%. (auth)

13609 GAMMA-RAY CORRELATION FUNCTION IN THE ADIABATIC APPROXIMATION. J. S. Blair and L. Wilets (Univ. of Washington, Seattle). Phys. Rev., 121: 1493-9(Mar. 1, 1961).

The γ-ray correlation function following inelastic excitation of an even-A nucleus by a spinless projectile was analyzed, employing only the adiabatic approximation and theorems relevant to elastic scattering. The direction making equal angles with the incident and scattered directions in the scattering plane, the adiabatic recoil direction, is a convenient axis for quantization. In particular, the intermediate (excited) nucleus is populated with only even-M states, from which follows that the γ distribution is unchanged by a rotation of π about this axis. For a $0^+ - 2^+ - 0^+$ excitation de-excitation, the γ distribution in the scattering plane reduces to the form $\sin^2[2(\theta_\gamma - \theta_0)]$, where θ_0 is the adiabatic recoil axis. Comparison is made to the similar predictions of plane-wave Born approximation theories (in which the recoil direction for finite energy transfer is the symmetry axis) and to distorted-wave Born approximation calculations (for which, in general, there is no simple expression for the symmetry axis). Analysis of experiments verify the general features of the model, but further data obtained from forward scattering would be desirable to distinguish between the predictions of the adiabatic and Born approximations. Brief comments are made regarding γ-ray polarization. (auth)

13610 LOW-ENERGY p-p SCATTERING PHASE SHIFTS AND DISPERSION RELATIONS. Riazuddin (Panjab Univ., Lahore, Pakistan). Phys. Rev., 121: 1509-12 (Mar. 1, 1961).

Nucleon-nucleon dispersion relations have been used to discriminate among various sets of solutions for low-energy proton-proton scattering. These relations greatly reduce the ambiguity existing in the phase-shift analysis at low energy. (auth)

13611 INVESTIGATION INTO THE ELASTIC SCATTERING OF $\Sigma^\pm$ HYPERONS ON HYDROGEN. F. Russell Stannard (Univ. of California, Berkeley). Phys. Rev., 121: 1513-22(Mar. 1, 1961). (UCRL-9389)

An investigation was made into the elastic scattering of Σ hyperons on hydrogen. The experiment was based on a sample of 12,000 Σ particles formed in a propane bubble chamber by the interactions of 1.15 Bev/c K^- mesons. A total track length of 210 meters in the energy range 100 to 700 Mev was examined. Ten examples were found of the reaction $\Sigma^+ + p \rightarrow \Sigma^+ + p$ and six of the reaction $\Sigma^- + p \rightarrow \Sigma^- + p$. The estimates of the cross sections for the two processes are, respectively, 38^{+18}_{-14} mb and 10^{+6}_{-4} mb. The scattering angle distributions in the c.m. system appear isotropic for the Σ^+ particles and peaked forward for the Σ^- particles. The results are discussed in relation to the triplet odd-parity nucleon-nucleon potential. (auth)

13612 ANALYSIS OF K-MESON PRODUCTION BY $\bar{p}$ ANNIHILATION. T. F. Hoang (Univ. of California, Berkeley). Phys. Rev., 121: 1523-4(Mar. 1, 1961). (UCRL-8994 Rev.)

K-meson production by $\bar{p}$ annihilation was investigated using an isobar model. A comparison of the predictions of this model with the experimental data excludes the assumption of an isobar state of $(\pi\pi)$ having a mass greater than three pion masses. (auth)

13613 ANTIPROTON ANNIHILATIONS IN PROPANE. Sulamith Goldhaber, Gerson Goldhaber, Wilson M. Powell, and Rein Silberberg (Univ. of California, Berkeley). Phys. Rev., 121: 1525-33(Mar. 1, 1961). (UCRL-9319)

An experiment to study the $\bar{p}$ annihilation process at 1.05 Bev/c was performed with the Lawrence Radiation Laboratory 30-in. propane bubble chamber. It was observed that the K-meson production in annihilation events rises sharply with the increase in energy, namely from $4 \pm 1\%$ for annihilations at or near "rest" to $8 \pm 1\%$. On the other hand, the pion multiplicity was not observed to increase appreciably with the increase of available energy. A pion multiplicity of 5.0 ± 0.2 was found. These numbers are discussed and compared with existing models for the $\bar{p}$ annihilation process. It is pointed out that with further increase in bombarding energy different models may differ appreciably in the above quantities. A $\bar{p}$-H annihilation cross section of 51 ± 10 mb and a $\bar{p}$-C annihilation cross section of 368 ± 60 mb was observed at a $\bar{p}$ momentum of 1.05 Bev/c. Crude determinations of the $\bar{p}$ charge-exchange process—which turns out to be forward peaked—and of $\bar{p}$ inelastic-scattering events leading to pion production are discussed. (auth)

13614 USEFULNESS OF POLARIZED TARGETS AND THE POLARIZATION TRANSFER TENSOR IN RECONSTRUCTION OF THE NUCLEON-NUCLEON SCATTERING MATRIX. Clifford R. Schumacher and Hans A Bethe (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 121: 1534-41(Mar. 1, 1961).

A method is presented for completely removing the ambiguities arising in the reconstruction of the nucleon-nucleon scattering matrix from data at a given angle and energy due to the bilinear form of expressions for observable quantities. The method utilizes only the amplitudes defined by Wolfenstein and Ashkin and is more direct and computationally simpler than the methods using unitarity and measurements at all angles or the phase-shift analyses; thus it provides an independent means of arriving at the correct set of phase-shift solutions. The method is based on a knowledge of the polarization transfer tensor K_{ik}, which has a form complementary to the familiar polarization correlation tensor C_{ik}. The K_{ik} tensor may be obtained from triple scattering experiments on the recoil nucleon similar to those used to determine the familiar depolarization tensor D_{ik}, or from double scattering measurements on nucleons scattered from a polarized target. It is also shown that the use of polarized targets has many experimental advantages. They would permit determination of the depolarization tensor D_{ik} for large scattering angles, without requiring the measurement of the polarization of a very slow nucleon; determination of the correlation tensor C_{ik} by the measurement of the cross section for the scattering of a polarized beam by a polarized target instead of the difficult simultaneous measurements of the polarizations of both the final nu-

cleons; and determination of the "difficult" components A' and R' of the D_{ik} and K_{ik} tensors by the measurement of the polarization of an initially unpolarized beam scattered by a polarized target. (auth)

13615 HIGH-ENERGY NUCLEON-NUCLEON COLLISIONS. Freda Salzman and George Salzman (Univ. of Colorado, Boulder). Phys. Rev., 121: 1541-4(Mar. 1, 1961).

The single virtual boson exchange interaction model is applied to high-energy inelastic nucleon-nucleon collisions over an energy range of several orders of magnitude. The phase space is discussed simply in terms of three "natural" phase-space variables, and a simple, exact formula is given for the "upper" boundary of these variables. The probability for a particular final-state configuration is then discussed in terms of the available phase space, the magnitude of the phase-space factor, and the magnitude of the average total "cross-section" factors that occur in this model. Qualitative features of experimental data for incident nucleon laboratory energies of 10, 10^2, and 10^3 Bev can be understood on the basis of this model. (auth)

13616 CROSS SECTION AND DECAY ASYMMETRIES OF NEUTRAL V PARTICLES PRODUCED IN COPPER BY π^- MESONS. George R. Kalbfleisch (Univ. of California, Berkeley). Phys. Rev., 121: 1544-9(Mar. 1, 1961). (UCRL-9219)

The charged modes of decay of 189 Λ and 77 K^0 particles produced by 1.12-Bev/c π^- mesons in the copper wall of the Berkeley 10-in. liquid hydrogen bubble chamber were analyzed and their asymmetries calculated. The asymmetries were examined for several interesting subgroups of the sample and for several directions of quantization. The asymmetries found here for both Λ and K^0 are consistent with the assumption of the conservation of parity in the production process $\pi^- + p$ (in nucleus) $\rightarrow \Lambda + K^0$. The cross section for the associated production of ΛK^0 and $\Sigma^0 K^0$ was determined as 10.5 ± 0.9 mb per copper nucleus. This value is somewhat larger than that expected on the assumption that the nucleons interact in first approximation as free nucleons possessing Fermi momentum according to an $A^{2/3}$ scaling of the hydrogen cross sections. This scaling predicts a value for this cross section of 7.4 ± 0.8 mb/nucleus. Subsequent interactions of the hyperons with another nucleon in the same nucleus in which they were produced are frequent. A lower limit for the probability of scattering of the Λ can be set at 0.23 ± 0.07. This is in accordance with the observed $\Lambda + p$ cross sections. (auth)

13617 TWO-PION EXCHANGE MECHANISM IN K^+N SCATTERING. Benjamin W. Lee (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 121: 1550-2(Mar. 1, 1961).

The exchange of two pions resonating in the T = 1, J = 1 state between the K^+-meson and nucleon in K^+N scattering is considered in the double dispersion representation to account for the energy dependence of the $J = \frac{1}{2}$ amplitudes. (auth)

13618 SPIN AND PARITY ANALYSIS FROM PRODUCTION AND DECAY OF HYPERON RESONANT STATES. R. Gatto and H. P. Stapp (Univ. of California, Berkeley). Phys. Rev., 121: 1553-5(Mar. 1, 1961).

Processes dominated by the Λ-π resonance state, Y*, should exhibit correlations permitting the determination of the Y* spin; the relative parities of the Λ, Σ, K, and Y*; and the ratios of the various hyperon decay asymmetry parameters. The cases of Y* spin $\frac{1}{2}$ and $\frac{3}{2}$ are examined in detail and a number of exact relations between measurable quantities are given for the various spin and parity assignments. The longitudinal component of polarization of the hyperon from the Y* decay is, for parity-conserving reactions, the same for all final hyperons, independent of their parities. This allows the ratio of the decay asymmetry parameters for various hyperons to be determined. For a given Y* spin the transverse hyperon polarization is determined by the longitudinal polarization up to a sign which is fixed by the Y*-hyperon parity. Thus the transverse polarizations for final Λ and Σ particles are the same or opposite if the parities are the same or opposite, respectively. For the spin $\frac{3}{2}$ case there are four independent contributions to the longitudinal polarization, each proportional to a different pseudoscalar spherical harmonic of the decay direction. These give four independent experimental determinations of the ratios of the decay asymmetry parameters. Similarly, from the transverse components there are six independent determinations of relative parities. If the initial and final states of the production process are restricted to S and P waves, all ten of the experimental parameters determining the hyperon polarization are given, except for the aforementioned sign dependence on the Y*-Y relative parity, by a single parameter in a manner fixed by the K-Y* parity. (auth)

13619 SCATTERING BY A BOUNDED NON-LINEAR SINGULARITY. E. A. Power and I. Saavedra (Manchester Univ., Eng.). Proc. Cambridge Phil. Soc., 57: 121-30 (Jan. 1961).

An investigation was made of the effect of a nonlinear addition to Schrödinger's equation for S-wave scattering of a beam of particles by a finite region of potential energy. The nonlinear region was bounded and of an especially simple form so that an analytic solution was possible. The R function for the problem was explicitly constructed, and some related formulas such as the resonant energies and the scattering length are given. The analytical nature of R as a function of the momentum considered as a complex variable is discussed in relation to causality. (auth)

13620 SOME REMARKS ON THE STRUCTURE OF ELEMENTARY PARTICLE INTERACTIONS. Alladi Ramakrishnan, A. P. Balachandran, and N. R. Ranganathan (Univ. of Madras). Proc. Indian Acad. Sci., Sec. A, 53: 1-11(Jan. 1961). (In English)

The existence of symmetries which can lead to minimal electromagnetic interactions have been investigated and three specific invariances to obtain this minimal character have been proposed. Applications of these principles to strong and weak interactions are seen to lead to certain suggestive results. A model of strong interactions arising out of these considerations is also discussed. (auth)

13621 SPIN CORRELATION MEASUREMENTS IN p-p SCATTERING AT 382 AND 320 MeV. J. V. Allaby, A. Ashmore, A. N. Diddens, J. Eades, G. B. Huxtable, and K. Skarsvåg (Univ. of Liverpool). Proc. Phys. Soc. (London), 77: 234-56(Feb. 1, 1961).

Measurements of the spin correlation coefficients C_{nn} and C_{KP} in p−p scattering at a 90° center-of-mass scattering angle are given. C_{nn} was measured at 382 and 320 Mev; C_{KP} at 382 Mev. The method of calibrating the polarization analyzers is described, and details are given of the corrections for random coincidences and for the geometrical contribution to asymmetry. (auth)

13622 THE S WAVE PION-PION INTERACTION. G. R. Allcock and A. N. Kamal (Univ. of Liverpool). Proc. Phys. Soc. (London), 77: 278-92(Feb. 1, 1961).

The pion−pion interaction was studied, with an explicit appeal to the standard quantum field theory. Lowest-order perturbation-theory calculations indicate that the usual re-

normalization procedure may imply an indefinite quantization metric. An alternative procedure, using a regulator cut-off near the nucleon mass, is therefore adopted; and on this basis the following conclusions are drawn. The short range pion–pion interaction is found to be highly repulsive in states of isobaric spin I = 0 and 2, giving a hard-core scattering. The short-range repulsion vanishes in the states with I = 1. The long-range interaction is attractive in the even isobaric spin states but is very small. An effective pion–pion coupling constant is obtained in terms of a_0 and a_2, the hard-core radii in states of isobaric spin I = 0 and 2, and μ, the meson rest mass: $\lambda_{eff} \simeq (16\pi/5)\, a_0\mu \simeq (16\pi/2)\, a_2\mu$. (auth)

13623 MULTIPLE GEIGER COUNTER COINCIDENCES DUE TO GAMMA RADIATION. J. C. Barton (Northern Polytechnic, London) and E. G. Michaelis. Proc. Phys. Soc. (London), 77: 377-84(Feb. 1, 1961).

Triple coincidences produced in Geiger counters by single γ rays were found to contribute to the rate of genuine coincidences in unscreened cosmic-ray telescopes at great depths below ground. This effect was examined by a separate anticoincidence experiment and is shown to be compatible with the hypothesis of successive Compton scatters of a single γ-ray quantum in the three counters. (auth)

13624 INTEGRABLE MANY BODY WAVE FUNCTIONS FOR A SYSTEM OF BOSE PARTICLES. S. F. Edwards and M. A. Naqvi (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 77: 433-46(Feb. 1, 1961).

By means of a parametric representation, a variational calculation for a system of Bose particles can be made by use of explicit trial wave functions describing a state with a fixed number of particles and including pair correlations. For the ground state, the results of previous work are obtained as the first term in a steepest descent calculation. An effective Schrödinger equation is obtained for the relative motion of two particles. The application of the method to excited states is discussed. For the case of a vortex line in the system, the method leads to an analysis that is similar to that for the ground state and that can be made in the same way. (auth)

13625 THEORY OF ELECTRON CORRELATION IN ATOMS AND MOLECULES. Oktay Sinanoğlu (Univ. of California, Berkeley). Proc. Roy. Soc. (London) A, 260: 379-92(Mar. 7, 1961). (UCRL-9365)

Corrections to the Hartree-Fock (H.F.) wave function, Φ_0, and energy of a many-electron system are given. By the use of operator techniques in perturbation theory, the first-order w.f., X_1^i, was obtained in terms of pair functions. These satisfied equations just like those of an actual two-electron system, except that each electron moved in the H.F. field of the entire N-electron medium added to the field of nuclei. Every pair function had to be orthogonalized to each of the two H.F. orbitals associated with it to get the complete X_1^i. This X_1^i determined both E_2 and E_3. The second-order energy, E_2, was the sum of pair interactions and three- and four-body correlations due to the exclusion principle. The latter may be incorporated into the pair energies if each pair function is orthogonalized also to the remaining H.F. orbitals of Φ_0. The approach allowed the valence and inner shells, etc., to be discussed separately and extended some of the concepts of quantum chemistry based on orbital approximations so as to include correlation. (auth)

13626 BARYON PARITY AND POLARIZATION EXPERIMENT. Kiyoshi Nakayama (Shizuoka Univ., Japan). Progr. Theoret. Phys. (Kyoto), 24: 953-62(Nov. 1960). (In English)

Possible polarization experiments from which information about baryon parity can be gained are investigated using the reactions $\Sigma^+ + p \rightarrow \Lambda^0 + n$, $\Xi^- + p \rightarrow (\Lambda^0 + \Lambda^0)$, $(\Sigma^0 + \Lambda^0)$, $(\Sigma^+ + \Sigma^-)$ and $\Xi^- + He^4 \rightarrow {}_\Lambda H^4\, \Lambda^0$. In these experiments the transversely polarized hyperon beam is scattered on the unpolarized target, p or He^4, and useful information is obtained by measuring the transverse components of polarization of the final products. All experiments presented appear to be possible in the near future. (auth)

13627 ON THE THEORY OF REARRANGEMENT COLLISIONS. Sigenobu Sunakawa (Rice Inst., Houston, Tex.). Progr. Theoret. Phys. (Kyoto), 24: 963-79(Nov. 1960). (In English)

The formal theory of rearrangement collisions is developed from the standpoint of the S-matrix and is formulated in such a way that the asymptotic Hamiltonian is the same for the final and initial states. The orthogonality of these states makes it possible to formulate the theory of rearrangement collisions in a way similar to that of single potential scattering. The "prior-post" discrepancy is discussed and the generalized optical theorem is derived. (auth)

13628 SOME CONSIDERATIONS ON THE LOW-ENERGY PION-NUCLEON SCATTERING. Kin-ichi Ishida (Yamagata Univ., Japan). Progr. Theoret. Phys. (Kyoto), 24: 980-90(Nov. 1960). (In English)

The unsubtracted Chew dispersion relations are reinterpreted as the approximate equations for low-energy pion-nucleon scattering, with the addition only of the invariant momentum transfer function (κ^2), in which the effect of the pion-pion interaction is partially included. Using these dispersion relations, the effects of the pion-pion interaction to the pion-nucleon scattering are discussed. (auth)

13629 ISOBAR MODEL AND THE S-WAVE PION-NUCLEON SCATTERING. Yasunori Fujii (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 24: 1013-32(Nov. 1960). (In English)

For the scattering lengths of the S-wave pion-nucleon scattering, it is shown that the result of the Chew-Goldberger-Low-Nambu (CGLN) dispersion relation without subtraction exhibits an excellent agreement with observation so long as the integrations are carried out over the 3-3 resonance alone. Correspondence of this result to the Hamiltonian formalism is examined by replacing the 3-3 resonant state by an isobaric particle of spin 3/2, which is described by the Rarita-Schwinger theory. The scattering amplitudes are calculated by means of the lowest order perturbation theory. By requiring further that the amplitudes should decrease to zero in the high-energy limit, it is found necessary to introduce interaction terms other than the conventional one. These terms are left undetermined from the location and the width of the 3-3 resonance. By the appropriate choice of the parameters involved in these terms, CGLN's result can be reproduced in the narrow width approximation. (auth)

13630 A SEMIPHENOMENOLOGICAL PROTON-PROTON POTENTIAL. Tetsuo Hamada (Univ. of Sydney). Progr. Theoret. Phys. (Kyoto), 24: 1033-48(Nov. 1960). (In English)

An energy independent potential is constructed which reproduces all available p-p data up to 310 Mev. At 310 Mev the potential predicts the MacGregor phase-shift solution. The potential includes the central, tensor, linear, and quadratic LS potentials. The quadratic LS potential is manifestly required in the singlet, even-parity state where the linear LS potential vanishes. The linear LS potential turns out to be more singular but of shorter range than

previously thought. It appears now that the p-p data below 310 Mev can be understood in terms of a potential consistent in all respects with the pion theory of nuclear forces. (auth)

13631 A NOTE ON EXCHANGE REACTION. Tatuya Sasakawa (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 24: 1125-7(Nov. 1960). (In English)

The quasi-elastic scattering reaction (p,p'), and the charge exchange reactions (p,n) and (n,p) are considered. A theory for the scattering amplitudes for these reactions is analyzed, in which the scattering amplitude is expressed as the square root of the sticking factor times the dynamical factor. The scattering matrix elements involving the incident and ejected particles are given in the impulse approximation for the above reactions. The dynamical factors of the matrix elements for elastic scattering and charge exchange are found to differ. On the basis of this difference, it is found that the proposed theory is applicable only to inelastic scattering reactions (p,p'). (T.F.H.)

13632 MASS DIFFERENCES OF CHARGED AND NEUTRAL STATES OF ELEMENTARY PARTICLES. Ira M. Freeman (Rutgers Univ., New Brunswick, N. J.). Progr. Theoret. Phys. (Kyoto), 24: 1128-9(Nov. 1960). (In English)

An empirical equation is given for determining the mass differences between charged and neutral particles of a given species, such as π^0 and $\pi^\pm$ mesons. The results of the equation are compared to observed mass differences for π mesons, K mesons, nucleons, Σ hyperons, and Ξ hyperons. (T.F.H.)

13633 ELECTRIC POLARIZABILITY OF NUCLEON. Tetsuo Sawada (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 24: 1132-4(Nov. 1960). (In English)

The electric polarizabilities of the neutron (α_n) and proton (α_p) are calculated to be $(1.0 \pm 0.4) \times 10^{-42}$ and $(0.75 \pm 0.25) \times 10^{-42}$ cm^3, respectively. It is found that gamma-nucleon (γ,N) reactions are important in the calculations. The cross sections for γ-N elastic scattering are required, and the cross sections for π^0 and π^+ photoproduction in γ-p interactions in the S and P wave approximations must be found. The value of α_p may be calculated directly from these data, but additional deuteron reaction data are needed in the calculation of α_n. (T.F.H.)

13634 STRANGE PARTICLES CONTRIBUTION TO THE MAGNETIC MOMENTS OF THE NUCLEON. Kung Hsüch-hui (Nankai University, China). Wu Li Hsüeh Pao, 16: 57-60(1960). (In Chinese)

The anomalous moment of nucleons with different strange particle masses was calculated and compared with the data of S. N. Gupta (Phys. Rev. 111, p.1432, 1958) who does not consider the effect of the strange particle masses. (R.V.J.)

13635 THE INFLUENCE OF POLARIZATION EFFECT ON ENERGY LOSS OF ELECTRONS PASSING THROUGH DIELECTRICS. Hsiao Chen-hsi and Chou Teh-lin. Wu Li Hsüeh Pao, 16: 98-106(1960). (In Chinese)

The influence of the polarization effect on the energy loss of low-energy electrons passing through different dielectrics was investigated. The average and most probable energy losses of 0.3 to 1.0-Mev electrons passing through beryllium, carbon, and aluminum foil were measured by using a Wilson cloud chamber filled with hydrogen. The experimental results indicated that in such energy region the energy loss of electrons passing through dielectrics, possessing large f_0-and ρ-value, such as beryllium and carbon, is appreciably reduced owing to the polarization effect, where f_0 is the ratio of the number of conducting electrons to that of total electrons in the dielectrics and ρ is the resistivity of the dielectrics. The experimental value of the energy loss of electrons passing through beryllium is smaller than the theoretical values given by Halpern and Hall, and by Sternheimer, who have taken into account the polarization effect; the experimental value of energy loss of electrons passing through carbon lies between the two theoretical values. (auth)

13636 THE BRANCHING RATIO OF RADIATIVE DECAY OF π^+ MESONS. Chen Yen-fa and Song Yuh (Chung-San University, China). Wu Li Hsüeh Pao, 16: 247-51 (1960). (In Chinese)

The branching ratio of $\pi^+ \rightarrow e^+ + \nu + \gamma$ to $\pi^+ \rightarrow \mu^+ + \nu$ was calculated by the standard perturbation method. The universal Fermi weak interaction of V−A type and a strong interaction proposed by Salam were assumed. The result did not contradict with the most recent experiment. (auth)

13637 DISPERSION RELATIONS FOR PION PRODUCTION IN PION-NUCLEON COLLISIONS. Chou Kuan-chao (Peking University, China) and Dai Yuan-ben. Wu Li Hsüeh Pao, 16: 252-62(1960). (In Chinese)

Dispersion relations for pion production in pion-nucleon collisions are discussed. The scattering amplitude is written in a form in which the operators of nucleon field are extracted from the state vectors of the initial and final states. The kinematics and symmetry properties were worked out in detail and the contribution of bound state was evaluated. (auth)

13638 THE RADIOACTIVE DECAY OF π-MESON. Kwo She-hung (Chungshan University, China). Wu Li Hsüeh Pao, 16: 299-304(1960). (In Chinese)

The relative probability of the radioactive decay of the π meson to that of $\pi \rightarrow \mu$ decay was calculated, assuming a universal Fermi interaction of V−A type. Terms in addition to those of usual gage invariant treatment were calculated with perturbation theory. The result does not contradict the experiment. (auth)

Neutron Physics

13639 (DEG-Report-270) A FINITE MEDIUM DIFFUSION THEORY. PART I. BARE SPHERES. R. T. Ackroyd, A. Campbell, and H. W. Haskey (United Kingdom Atomic Energy Authority. Development and Engineering Group, Risley, Lancs, England). Nov. 4, 1960. 17p.

Diffusion equations are obtained for the neutron density in critical and absorbing spheres. The Laplacians and diffusion coefficients are found to be functions of both the composition and size of the isotropic scattering medium filling the spheres. The results reduce to the classical ones of modified diffusion theory when the radius of the sphere is large and the sphere is either critical or weakly absorbing. A solution is found for strongly absorbing spheres, which has no analogue in infinite medium theory. The new theory predicts smaller critical radii than those given by modified diffusion theory. The difference in radii is significant when the radii are of the order of a few mean free paths. The new theory does not use an extrapolation length in determining critical size. Absorbing spheres are treated assuming a uniform isotropic source of neutrons on the surface. For strong absorbers, the solution for the neutron density increases very rapidly with distance from the center of the sphere. The ratio of escapes to entries for thermal neutrons incident on a bare sphere of natural uranium is calculated by finite medium and classical diffusion theories, and the results are compared with a Monte Carlo calculation. The escapes to entries for the neutron current incident on the sphere, as calculated by the finite

medium diffusion theory, are almost within the statistical uncertainty of the Monte Carlo calculation for spheres of diameters up to 3 cm. (auth)

13640 (GAMD-1920) ANALYSIS OF CERTAIN EXPERIMENTS INVOLVING SPATIALLY DEPENDENT THERMAL NEUTRON SPECTRA. R. Engelmore (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 7, 1960. Contract AT(04-3)-314. 31p.

A variational method for handling certain types of space-dependent neutron thermalization problems is described and applied to two cases for which experimental data are available. Measurements of the thermal activation rates of "1/v" absorbers as a function of distance from a temperature discontinuity in a pure graphite moderator and of the Pu^{239} to U^{235} fission ratio in TREAT were analyzed. (M.C.G.)

13641 (HW-60422(Rev.)) NOTES ON LATTICE PARAMETER CALCULATIONS. G. D. Joanou. Revised by R. E. Tiller (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 6, 1960. Contract AT(45-1)-1350. 21p.

Recent information on the calculation of reactor lattice parameters is presented on the following topics: resonance and escape probability, fast effect, calculation of η, thermal utilization, conversion ratio, diffusion length, Fermi age, streaming corrections, and migration area. (D.L.C.)

13642 (NAA-SR-Memo-968) NEUTRON FLUX MEASUREMENTS IN THORIUM RODS. D. H. Martin (North American Aviation, Inc., Downey, Calif.). Apr. 22, 1954. Decl. Nov. 6, 1958. 10p.

A study was made of the thermal and resonance neutron fluxes in 1-in.-diameter thorium rods. The rod was introduced into an experimental lattice of 1-in.-diameter, slightly enriched uranium rods in D_2O by substituting specially machined thorium slugs for part of the uranium slugs in one of the rods. These slugs were placed in aluminum tubes. Two of the thorium slugs were drilled to permit insertion of neutron-detecting foils at various positions on the radius. Both thorium and dysprosium foils were used. The relative flux was plotted against the square of the radius for area comparison purposes. The resonance and thermal disadvantage factors of the rod were evaluated by measuring areas under the curves and comparing average fluxes. (M.C.G.)

13643 (NYO-7877) SUMMARY OF NEUTRON MEASUREMENT METHODS. Technical Memorandum No. 35. Herman L. Miller (Princeton Univ., N. J. Project Matterhorn). Oct. 24, 1956. 16p.

A summary is given of methods used for measuring neutron fluxes, proton recoil methods, and nuclear reactions. The moderation of neutrons is discussed. Electronic equipment necessary for neutron measurement studies are described. 24 references. (B.O.G.)

13644 (TID-11560) EFFECTIVE MULTIGROUP NEUTRON DIFFUSION COEFFICIENTS FOR RODS, ANNULI, OR SLABS (ANP PROGRAM 556). W. B. Henderson (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Sept. 2, 1960. Contracts AF 33(600)-38062 and AT(11-1)-171. 32p. (XDC 60-11-151)

ANP Program 556 computes neutron diffusion coefficients that in a diffusion-theory approximation will preserve the albedos of a cylinder or slab obtained from a higher order approximation, such as the method of success collisions, in absorbers of infinite extent or numerical leakage escape calculations for finite regions of low density. Such regions in multigroup diffusion calculations can then be represented by group constants that produce the same average neutron loss rate as the albedo boundary condition. (auth)

13645 (UCRL-6076) 9-ANGIE—A TWO-DIMENSIONAL, MULTIGROUP, NEUTRON-DIFFUSION-THEORY REACTOR CODE FOR THE IBM 709 OR 7090. Stuart P. Stone (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 28, 1960. Contract W-7405-eng-48. 51p.

The 9-ANGIE, one of a series of reactor neutronic programs for an IBM 709 or 7090 data processing system, solves the time-independent multi-group neutron diffusion equation for one to eighteen energy groups applied to a rectangular mesh superimposed on either an x-y or an r-z plane. It is characterized by its generalaties in region description and boundary conditions, without sacrificing simplicity of input preparation and ease of machine operation. The notation, style, and format were held as consistent as possible with 9-ZOOM. (auth)

13646 (USNRDL-TR-478) NEUTRON DISTRIBUTIONS NEAR AN AIR-SOIL BOUNDARY. W. E. Thompson, J. M. Ferguson, and R. L. Mather (Naval Radiological Defense Lab., San Francisco). Nov. 18, 1960. 78p.

Given an air burst of a nuclear weapon at height x, then for horizontal distances from ground zero greater than x the vertical spatial distribution of neutrons is assumed to remain essentially invariant. A method applicable in such regions, using discrete space-energy "bins" and a number of assumptions, is described by which energy and spatial distributions of neutrons above and below an air-soil boundary can be predicted. A number of results derivable from the theoretical treatment are compared with experimental results obtained in the field. (auth)

13647 (WAPD-TM-218) MUFT-5—A FAST NEUTRON SPECTRUM PROGRAM FOR THE PHILCO-2000. H. Bohl, Jr. and A. P. Hemphill (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Feb. 1961. Contract AT-11-1-GEN-14. 94p.

The program was written for the Philco-2000 computer to provide a nuclear design computing tool equivalent to the IBM-704 computer program MUFT-4 and to provide a set of routines for a future spatial multigroup program, P_3MG-1. In addition to the features of its 704 predecessor, MUFT-5 provides a more complete isotopic edit, an optional blackness coefficient edit, and the use of a complete P_1-library. The resultant program is found to be easier to use because of the simplicity of running several problems, more valuable because of the many additional results that are edited, and more economical because of the changes made in programming. (auth)

13648 (YAEC-149) THE DANCOFF CORRECTION TO THE RESONANCE ABSORPTION IN CLOSE-PACKED CYLINDRICAL FUEL ROD LATTICES. R. J. French (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Dec. 1960. For Yankee Atomic Electric Co., Boston. Contract AT(30-3)-222, Subcontract No. 1. 57p.

The importance of an integral approach to the problem of the resonance escape probability in close-packed lattices is discussed. A review is preformed of the theoretical basis for the Dancoff correction to the effective resonance integral in close-packed lattices. Emphasis is given to a physical interpretation, which results in a clear understanding of the problems associated with its application. Although more questions are raised than are resolved, the solution to the problem of the determination of an effective resonance integral in a close-packed lattice is suggested with recommendations to implement the solution. A computer code, which was written to extend the results of Dancoff, is described and some results obtained from this code are presented. (auth)

13649 PARASITIC MULTIPLE BRAGG SCATTERING IN THE NEUTRON CRYSTAL SPECTROMETER. D. A.

O'Connor and J. Sosnowski (Inst. of Nuclear Research, Warsaw). Acta Cryst., 14: 292-7(Mar. 10, 1961). (In English)

Nuclear-reactor slow-neutron spectra obtained by the use of a crystal monochromator contain a number of irregular fluctuations in the form of inverted peaks, due to fluctuations in the reflectivity of the crystal. It is shown that these fluctuations are due to Bragg reflection of neutrons by reflecting planes other than that used to obtain the monochromatic beam. Approximate formulae are derived for the magnitude and half-width of these inverted peaks for a mosaic crystal. Experiments carried out with copper and aluminum single crystals confirm that the Bragg angles at which the peaks occur depend on the type of crystal structure and not on the lattice constants. The measured depth of the better defined peaks is in satisfactory agreement with the calculated on the basis of the approximate formulas. Comparison of measurements with the crystals at room temperature and liquid-air temperatures failed to reveal the presence of inelastic scattering as a contributory factor to the fluctuations in reflectivity. (auth)

13650 INFLUENCE OF ERGODIC BEHAVIOR ON THE SCATTERING OF SLOW NEUTRONS BY A HARMONIC OSCILLATOR. Theodore J. Krieger (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 121: 1388-90(Mar. 1, 1961).

Random quantum jumps of a harmonic oscillator in contact with a temperature bath are shown to give rise to a general broadening of the slow neutron scattering peaks. An exception occurs in the case of the elastic scattering peak, a major component of which remains unbroadened. In general, the broadening increases with the number of quanta transferred. The analysis is based on a "damped" oscillator model. (auth)

13651 THE QUASI-CLASSICAL APPROXIMATION FOR NEUTRON SCATTERING. R. E. Turner Clarendon Lab., Oxford). Physica, 27: 260-4(Feb. 1961). (In English)

The evaluation of Van Hove's space time correlation function in the quasi-classical approximation is discussed. It is shown that Schofield's imaginary time shift is correct to order $\hbar$ and furthermore that this approximation should be a very good one for most scattering substances, at moderately high temperatures. (auth)

13652 NEUTRON SCATTERING FROM A LIQUID ON A JUMP DIFFUSION MODEL. C. T. Chudley and R. J. Elliott (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 77: 353-61(Feb. 1, 1961).

The incoherent inelastic scattering cross section of slow neutrons from liquids is calculated using a simple model in which the liquid is assumed to have appreciable short-range order in a quasi-crystalline form. Diffusive motion takes place in large discrete jumps, between which the atoms oscillate as in a solid. The model predicts a definite, easily calculable cross section that is not dominated by diffusion effects as when continuous diffusion is assumed but shows a characteristic variation with angle which could be looked for experimentally. A brief discussion of the coherent scattering cross sections for the model is given although explicit formulas are not obtained. (auth)

Nuclear Properties and Reactions

13653 (ANL-6252) BUILDUP OF Cf^{252} AND INTERMEDIATE ISOTOPES FROM Cm^{244} IN A HIGH FLUX. S. E. Vandenbosch and P. R. Fields (Argonne National Lab., Ill.). Feb. 1961. Contract W-31-109-eng-38. 9p.

The amount of Cf^{252} and intermediate isotopes which could be made from Cm^{244} in a reactor with high neutron flux was calculated. The variations of different isotopes formed in the bombardment as a function of time are described by a series of linear differential equations. The cross sections used were either weighed measured values or values estimated from the amounts of curium and californium isotopes formed in irradiations of heavy elements. The number of atoms of heavy curium isotopes per initial Cm^{244} atom is given as a function of total flux intervals. The buildup of Bk^{249} and the californium isotopes is also shown. (M.C.G.)

13654 (BNL-653) NEUTRON CROSS SECTION EVALUATION GROUP NEWSLETTER NO. 3, FEBRUARY 1961. Rudolph Sher and Sophie Moore (Brookhaven National Lab., Upton, N. Y.). 8p.

Capture-to-fission ratios in U^{233}, U^{235}, and Pu^{239} are given as a function of neutron energies from 30 kev to 1 Mev. Excitation functions of fast-neutron-induced reactions are given for $Th^{232}(n,2n)Th^{231}$ from 8.4 to 15.1 Mev. Reduced neutron widths, Γ_n^0, are tabulated for calcium from 254 to 595 kev and lead-208 from 352 to 718 kev, as determined from the neutron total cross section resonance parameters. Measurements of neutron radiative cross sections for 49 nuclides are tabulated relative to indium at 30, 65, and 167 kev. (For preceding newsletter see BNL-634.) (B.O.G.)

13655 (BNL-5294) THE ANGULAR DISTRIBUTION IN ASSOCIATED PRODUCTION AND THE RELATIVE Λ, Σ PARITY. Mirza A. Baqi Beg, Jeremy Bernstein, and Paul C. DeCelles (Brookhaven National Lab., Upton, N. Y.). Jan. 31, 1961. 5p. (PD-23)

The data on the angular distribution of Λ and Σ hyperons in the reaction $\pi + N \rightarrow \Sigma, \Lambda + K$ are briefly reviewed and their implications discussed. The backward peaking of the hyperons is interpreted in terms of an intermediate K' particle which absorbs the π and is then converted into K. The problems of the observed large hyperon polarization and the difference in the energy dependences of the Λ and Σ angular distributions are discussed. It is concluded that the present picture of Λ and Σ production is too simple. (D.L.C.)

13656 (CEA-1531) CONTRIBUTION A L'ETUDE DES ETATS COLLECTIFS DES NOYAUX LOURDS PAR EXCITATION COULOMBIENNE. (Contribution to the Study of Collective States of Heavy Nuclei by Means of Coulomb Excitation). Roland Barloutaud (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1960. 55p.

Thesis submitted to the Univ. of Paris, June 19, 1958.

The following nuclei were excited by protons of 5 Mev maximum energy: W^{182}, W^{184}, W^{186}, Os^{186}, Os^{188}, Os^{189}, Os^{190}, Os^{192}, Pt^{194}, Pt^{196}, Pt^{198}, Hg^{198}, Hg^{200}, Hg^{202}, Hg^{204}, and Pb^{206}. The reduced probabilities of the various transitions were deduced from the Coulomb excitation cross-section measurements. For some even-even nuclei two 2+ levels were excited. The properties of the excited levels are interpreted in terms of the collective model. (auth)

13657 (CERN-61-1) HIGH-ENERGY NUCLEAR REACTION CROSS-SECTIONS. E. Bruninx (European Organization for Nuclear Research, Geneva). Jan. 16, 1961. 107p.

A compilation is presented of formation cross sections in the region beryllium to copper for nuclear reactions above 50 Mev. (B.O.G.)

13658 (CERN-61-2) CROSS-SECTIONS OF $\nu + n \rightarrow p + e^-$ AND $\bar{\nu} + p \rightarrow n + e^+$. Yoshio Yamaguchi (European Or-

ganization for Nuclear Research, Geneva). Jan. 19, 1961. 37p.

Angular distributions for the neutrino processes $\nu + n \rightarrow p + e^-$ and $\bar{\nu} + p \rightarrow n + e^+$ are tabulated at several neutrino energies. The dependence of the cross sections on the form factors is explicitly shown for typical cases. The reaction cross sections for $\nu + n \rightarrow p + \mu^-$ and $\bar{\nu} + p \rightarrow n + \mu^+$ are briefly discussed. (auth)

13659 (CRC-1003) TABLE OF ESTIMATED CROSS SECTIONS FOR (n,p), (n,α) AND (n,2n) REACTIONS IN A FISSION NEUTRON SPECTRUM. J. C. Roy and J. J. Hawton (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1960. 39p. (AECL-1181)

A list of estimated activation cross sections of (n,p), (n,α), and (n,2n) reactions in a fission neutron spectrum is presented for a few long-lived radionuclides and the stable isotopes of elements from lithium to bismuth. It is also shown how to obtain from these quantities the cross sections for any fast-neutron-reactor spectrum and in particular for fast-neutron spectra typical of several irradiation positions of the NRX and NRU reactors at Chalk River. (auth)

13660 (CRT-984) RELATIVISTIC THEORY OF THE AUGER EFFECT. M. Chapdelaine (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Jan. 1961. 37p. (AECL-1173).

A derivation of the relativistic Auger effect is presented. Brief outlines are included of various consecutive theoretical steps involved in the derivation. The Auger transition probabilities are calculated using relativistic wave functions and working in j-j coupling. The radiation field is first quantized along known lines in spherical waves. This quantization is then applied to the interaction of two bound electrons, and finally the two-particle interaction matrix elements thus obtained are related to the transition probabilities of the atom, taking into account the antisymmetrization of the total wave function for the atom. (J.R.D.)

13661 (NP-9867(p.8-20)) THE INTERACTIONS OF He^3 AND T^3 WITH LIGHT NUCLEI. H. D. Holmgren and E. A. Wolicki (Naval Research Lab., Washington, D. C.).

The theoretical aspects of nuclear interactions are reviewed for several models, and data are presented in graphical form for the differential cross sections and angular distributions for the following reactions: $C^{12}(He^3,p)$, $Be^9(He^3,p)$, $B^{11}(He^3,d)$, $B^{10}(t,d)$, $C^{12}(t,p)$, $C^{13}(He^3,\alpha)$, and $C^{12}(t,\alpha)$. The results suggest that the direct interaction is the dominant interaction mode leading to low-lying levels produced by He^3 and t bombardment, even at low bombarding energies. A conservation rule for α particles is presented. (D.L.C.)

13662 (NP-9867(p.21-6)) STRIPPING OF TWO NUCLEONS WITH EXCHANGE EFFECTS. I. Manning and A. H. Aitken (Naval Research Lab., Washington, D. C.).

(He^3,p) reactions are viewed as direct interactions in which the outgoing proton is stripped from the He^3 projectile, the remaining neutron and proton being captured by the target. Calculations of the double stripping effect in such interactions are made using a corrected modification of Nadi's method, which includes exchange or backward stripping. The results can be applied to analysis of (He^3,p) reaction data. (D.L.C.)

13663 (NP-9867(p.31-5)) COINCIDENCE PROBABILITIES. C. V. Strain (Naval Research Lab., Washington, D. C.).

General expressions are derived for the probabilities of all possible interactions of n simultaneous events with arrays of detectors limited only by the requirement that detectors be of not more than two kinds. Two examples are included. (auth)

13664 (NP-9880) DYNAMIC POLARIZATION OF NUCLEI BY ELECTRON-NUCLEAR DIPOLAR COUPLING IN CRYSTALS. Technical Report No. 6. O. S. Leifson and C. D. Jeffries (California. Univ., Berkeley). Jan. 1961. 68p. Contract Nonr-222(61).

A detailed investigation was made of the dynamic polarization of the protons in $(Ce, La)_2Mg_3(NO_3)_{12} \cdot 24H_2O$ which occurs when the "forbidden" microwave transitions that simultaneously flip a proton spin and a Ce^{3+} electron spin are saturated. The rate equations for the electron and nuclear polarization were solved for a simple ideal model; a model for the case where the forbidden lines are not resolved; and a model taking into account nuclear spin temperature diffusion. An apparatus for simultaneous observation of proton magnetic resonance and Ce^{3+} paramagnetic resonance at liquid helium temperatures is described. The Ce^{3+} spin-lattice relaxation time (T_{1e}) was directly measured by a transient method and it was found that $T_{1e} \propto T^{-14\pm2}$ for temperatures in the range $1.9°K < T < 2.7°K$. In the same crystals the proton relaxation time (T_{1n}) was also measured by a transient method and found to be $T_{1n} \propto T^{-1}$ and dependent on the concentration of Ce^{3+} ions. The relative magnitudes of T_{1n} and T_{1e} are best explained by a model intermediate between the first and third. At $T \approx 1.5°K$ and a microwave frequency $\nu_e \approx 9.3$ kMc, the proton polarization was observed for a number of different concentrations of Ce^{3+}. The magnitude of the polarization, its dependence on magnetic field and microwave power, and the transient behavior were studied and qualitatively explained. In a crystal containing 1% cerium the proton polarization was observed to become greater than the thermal equilibrium value by the factor 150, which is about one-quarter of the theoretical ideal. At higher microwave frequencies ($\nu_e \approx 50$ kMc) it should be possible to obtain in this crystal sufficient proton polarization (~25%) to be useful for dynamic nuclear cooling experiments and nuclear targets. (auth)

13665 (NP-9895) NUCLEAR COLLECTIVE MOTION AND THE SHELL MODEL. Technical Report No. 6. Michel Baranger (Carnegie Inst. of Tech., Pittsburgh). [1961?]. Contract Nonr 760(15) NR 012-202. 16p.

Recent work on the shell-model interpretation of nuclear collective effects is reviewed. Some of these effects are the giant dipole resonance, octupole oscillations, and quadrupole vibrations. The calculation of nuclear shapes, starting from a shell-model Hamiltonian, is treated with the Hartree-Fock method and the independent quasi-particle model. (D.L.C.)

13666 (NYO-9280) EXPERIMENTS ON THE ABSORPTION OF POLARIZED NEGATIVE MU MESONS BY C^{12}. Bernard L. Bloch (Carnegie Inst. of Tech., Pittsburgh). Nov. 1960. Contract AT(30-1)-882. 90p.

Experiments performed in an effort to supply evidence for the universality of the V-A theory in weak interactions and for the law of conservation of leptons are described. In the first part, the production rate of B^{12} by the absorption of negative μ mesons in carbon was measured. From the amplitudes of the muon decay curve and the boron decay curve, the rate was calculated to be $(5.8 \pm 1.3) \times 10^3$ sec^{-1}, in agreement with the hypothesis of a universal V-A theory. In the second part, an attempt was made to measure the helicity of negative μ mesons by stopping longitudinally polarized muons in a carbon target and observing the electron asymmetry in the β-decay of the spin-1 B^{12}. The results of this part were inconclusive, a consequence attributed to a short boron thermal relaxation time. (auth)

13667 (NYO-9281) ELASTIC SCATTERING OF NEGATIVE PIONS BY PROTONS AT 226 MEV (thesis). Simon Kellman (Carnegie Inst. of Tech., Pittsburgh). Dec. 1960. Contract AT(30-1)-882. 101p.

The total and differential elastic cross sections of 226-Mev π^- scattered by protons were measured. For detection of elastically scattered π^- only, the proton recoiling from the π-p collision was detected in coincidence with the associated scattered meson. Pulse height analysis of the Cherenkov radiation produced by the scattered beam was used to differentiate between π^- and electrons in the scattered particles. A total cross section of 52.9 ± 1.4 mb was measured. Analysis of the differential cross section data gave $d\sigma/d\Omega = (1.000 \pm 0.012)\ [(0.66 \pm 0.02) + (0.41 \pm 0.05)\cos\theta + (2.16 \pm 0.08)\cos^2\theta]$, which supports the hypothesis that only S and P waves contribute appreciably to the scattering. Integration gave a total elastic cross section of 17.4 ± 0.3 mb, in agreement with other recent measurements. The absolute value of the real part of the forward scattering amplitude was determined to be −0.129, which agrees with that calculated with pion dispersion relations. (auth)

13668 (TID-11511) ELASTIC AND INELASTIC SCATTERING OF ALPHA PARTICLES BY N^{14}. W. D. Ploughe (Purdue Univ., Lafayette, Ind.). [1960]. 15p.

The absolute differential cross section for the elastic and inelastic scattering of 19.2-Mev α particles by N^{14} was measured as a function of the scattering angle. The forward part of the ground-state angular distribution was fitted with the black-nucleus diffraction model of Blair using an interaction radius of 5.89×10^{-13} cm. The angular distribution for the Q = −3.95-Mev group was fitted with $[j_2(qR)]^2$ using an interaction radius of $R = 5.9 \times 10^{-13}$ cm. With the same interaction radius, a best fit to the data for the unresolved doublet, Q = −4.91 and −5.10 Mev, was obtained using the sum $[j_1(qR)]^2 + [j_3(qR)]^2$. The best fit by odd-order spherical Bessel functions is consistent with the assignment of negative parity to both the 4.91- and 5.10-Mev levels. (auth)

13669 (TID-11552) THE ACTIVITY OF THE FISSION PRODUCTS OF U^{235}. Supplement No. 1. M. R. Smith (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Nov. 10, 1960. Contracts AF33(600)-38062 and AT(11-1)-171. 75p. (XDC-60-12-46)

The fission product decay γ energy release rate from thermal fission of U^{235} is presented as a function of time after shutdown for reactor operation times of 1 sec, 1 hr, and 10^8 sec at a constant power level of 1 watt. The results were obtained by integrating the data for an instantaneous fission event for the decay γ high-energy groups over the given reactor histories. (auth)

13670 (TID-11554) ANP PROGRAM NUMBER 535, BERYLLIUM (n,2n) ENERGY TRANSFER CROSS SECTIONS. T. J. Kostigen (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Sept. 1, 1960. Contract AF 33(600)-38062 and AT(11-1)-171. 15p. (XDC-60-12-70)

A FORTRAN-II program used to compute energy transfer cross sections describing an (n,2n) reaction is described. The program was specifically intended for beryllium but applies also to other similar nuclei. The cross sections are presented as zeroeth and first Legendre moment, group-averaged, transfer cross sections. (auth)

13671 (TID-11561) THE STATUS OF NEUTRON CROSS SECTIONS AND RELATED DATA. A. Prince (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Oct. 20, 1960. Contracts AF33(600)-38062 and AT(11-1)-171. 97p. (XDC-60-11-164)

The current status of experimentally defined neutron cross sections for materials pertinent to shield analysis is presented. The experimental and theoretical techniques employed in obtaining data are outlined. Materials included are: H, Li, Be, R, C, N, O, Al, Cr, Fe, Co, Ni, Yb, Zr, Mo, W, Pb, and U. (auth)

13672 (TID-11571) U^{235} FISSION GAMMA RAY SOURCE DATA. J. G. Carver (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Oct. 5, 1960. Contracts AF 33(600)-38062 and AT(11-1)-171. 31p. (XDC-60-11-63)

The latest data available concerning γ rays associated with the fission of U^{235} both during fission and for long times afterward are presented. The data are tabulated in a convenient manner for use in shielding calculations. The γ rays are categorized as follows: (1) prompt, (2) short half life, (3) intermediate life, and (4) delayed γ rays. The data are not intended for use in predicting so-called shutdown dose rates but are to describe completely the radiation coming from a reactor during operation after that operation has continued for an appreciable time. (auth)

13673 (TID-11858) ENERGY AND ANGULAR DISTRIBUTION OF SECONDARY ELECTRONS PRODUCED BY 50-100 KEV PROTONS IN HYDROGEN GAS (thesis). Chris Ernie Earl Kuyatt (Nebraska. Univ., Lincoln). June 1960. 116p.

Hydrogen gas in a rotatable scattering chamber was bombarded by 50-, 75-, and 100-kev protons from a Cockcroft-Walton accelerator. The resulting secondary electrons were analyzed in both direction and energy by a slit system and a cylindrical electrostatic analyzer and counted by an electron multiplier tube with suitable electronics. Relative values of the differential cross section were measured for 0.2- to 300-ev electrons at angles of 23, 45, 67½, 90, 112½, 135, and 152° from the proton beam direction. As a function of electron energy at a fixed angle, the differential cross section shows a broad peak at 4 to 9 ev with a monotonic decrease at higher electron energies. As a function of angle, for fixed electron energy, the differential cross sections are largest at 23°, dropping off rapidly until 90°, then becoming relatively constant. Agreement with the results of Blauth at 54.5° is good for electrons from 8 to 100 ev and poor outside this range. Calculations made using the Born approximation are in very poor agreement with the experimental results. Extrapolation and integration of the results over all angles gives an energy distribution that is in poor agreement with the calculation of Bates and Griffing. Further integration over all electron energies gives relative total ionization cross sections that are not inconsistent with the measured values of Schwirzke. (auth)

13674 (UCRL-Trans-637) A SYSTEMATIC ANALYSIS OF HYPERFRAGMENTS WHICH WERE PRODUCED BY MEANS OF K^--MESONS, DECAYING BY THE π^--MESONIC MODE. J. Tietge (Max-Planck-Institut für Physik und Astrophysik, Munich). Translated by Barbara Trapp. [1958]. 33p.

A stack of nuclear emulsions exposed to the 300-Mev/c meson (K^-)-beam of the Berkeley Bevatron was scanned systematically for hyperfragments. Thirty-six hyperfragments decaying by the π^--mesonic mode were found. Twenty-four of these hyperfragments could be analyzed uniquely in the sense of the criteria given. Binding energies were obtained for ${}_\Lambda H^3$, ${}_\Lambda H^4$, ${}_\Lambda He^4$, ${}_\Lambda He^5$, ${}_\Lambda Li^8$, and ${}_\Lambda Li^9$. Angular, energy, and momentum distributions of the ${}_\Lambda He^5$ decay products were studied and compared with the corresponding theoretical distributions given by Byers and Cottingham. The mean lifetime for ${}_\Lambda H^4$-hyperfragments

was calculated. The nuclear capture of a Σ^- hyperon from which a hydrogen nucleus and a π^--meson were emitted is described. (auth)

13675 (UCRL-Trans-645) STUDIES ON THE RADIOACTIVE DECAY OF Th^{231}. S. A. Baranov, R. M. Polevoi, Yu. F. Rodionov, G. V. Shishkin, and V. M. Shubko. Translated from Izvest. Akad. Nauk, S.S.S.R., 24: 261-71(1960). 21p.

A study was made of the decay of Th^{231} in order to develop a scheme for the energy levels of the Pa^{231} nucleus. Th^{231} was obtained by irradiating Th^{230} in a slow neutron beam. Both β and γ spectrometric measurements were made. From these measurements the relative and absolute conversion coefficients for some transitions of the Pa^{231} nucleus were determined. The existence of levels in Pa^{231} at 58.5, 84.2, ~169, ~248, and ~300 kev was clearly indicated. However, complete analysis of data suggested that the level scheme cannot be limited by these energies. A possible scheme of energy levels was developed. (M.C.G.)

13676 ANGULAR CORRELATION BETWEEN NEUTRINO AND GAMMA-QUANTUM IN K-CAPTURE. [PART] II. K. Nagy (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 12: 193-8(1960). (In English)

With the use of the exact Dirac electron function for the K shell, the angular correlation is determined between neutrino and gamma quantum following a K capture. The V−A combination for β interaction is used, supposing the neutrino to be a backward longitudinally polarized particle. (auth)

13677 THE RANGE OF Na^{24} IONS OF KILOELECTRON VOLT ENERGIES IN ALUMINUM. J. A. Davies and G. A. Sims (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 39: 601-10(Mar. 1961). (AECL-1150)

Detailed studies are reported for the depth of penetration in aluminum of monoenergetic Na^{24} ions over the energy region 0.7 to 60 kev. Below 20 kev the median range (R_M) increased linearly with energy as predicted by the Bohr–Nielsen equation. As was observed in a previous study with Cs^{137} ions in aluminum, the experimental distribution curves were not Gaussian in shape but consisted of a markedly asymmetric peak followed by a pronounced exponential "tail." The results of a Monte Carlo calculation showed that the observed distribution curves correspond quite closely to those predicted by an isotropic elastic-scattering model. Above 20 kev a slight deviation from the linear range-energy relationship was observed; also, the distribution curves became narrower and more symmetrical, suggesting that electronic interactions are starting to play a significant role in the stopping process. Some preliminary results for the range of accelerated ions of Rb^{86} and K^{42} in aluminum are included for comparison. Median ranges for each of the alkali-metal ions are compared with those predicted by the Bohr–Nielsen treatment. (auth)

13678 ISOTOPE EFFECT IN HEAVY ION RANGE STUDIES. J. A. Davies, J. D. McIntyre, and G. A. Sims (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 39: 611-15(Mar. 1961). (AECL-1149)

From measurements of the isotope ratio (Na^{22}/Na^{24}) at various depths of penetration, it was possible to determine at 24 kev the small difference in the median ranges of the sodium isotopes. Sodium-22 had a slightly larger median range, as was predicted by the Nielsen equation. Monte Carlo calculations showed that an isotropic elastic-scattering model provides a reasonable explanation for the magnitude of the range difference and for the observed variation in the isotope ratio as a function of depth. (auth)

13679 THE KINETIC ENERGY OF Cs^{136} PRIMARY FRAGMENTS FROM FISSION OF U^{235}. F. Brown and B. H. Oliver (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 39: 616-27(Mar. 1961). (AECL-1151)

The ranges of Cs^{136}, Cs^{137}, and Ba^{140} fission fragments in aluminum were measured by using an anodizing technique to strip layers from the aluminum together with radiochemical methods to determine the fission products. The mean ranges are, in milligrams per square centimeter: Cs^{136}, 2.64; Cs^{137}, 2.91; and Ba^{140}, 2.82. The range distributions were of near-Gaussian form with the following percentage full widths at half height: Cs^{136}, 17.7; Cs^{137}, 17.0; and Ba^{140}, 17.5. The range-energy relation of Bohr, $R = \text{const.}\ A^{1/2} E^{1/2} Z^{-1/2}$, was tested by using the range data of Katcoff and of Niday, together with the kinetic-energy data of Milton and Fraser, and was found to be accurate, within experimental error, over any limited range of fragment masses. By this formula it then appears that the total kinetic energy in the fission mode leading to Cs^{136} is about 21 Mev less than normal. (auth)

13680 THE THERMAL NEUTRON FISSION YIELDS OF U^{233}. D. R. Bidinosti, D. E. Irish, and R. H. Tomlinson (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 39: 628-34(Mar. 1961).

With the use of the mass spectrometer and isotope-dilution technique, 27 cumulative fission yields from the thermal-neutron fission of U^{233}, along with 13 other fission-product chains relative to each other, were determined. After normalization of the latter, values were obtained for all but seven fission decay chains whose yields were in excess of 0.5%. (auth)

13681 DISTRIBUTION OF NUCLEAR CHARGE IN THE PROTON-INDUCED FISSION OF Th^{232}. PART II. A. Kjelberg, H. Taniguchi, and L. Yaffe (McGill Univ., Montreal). Can. J. Chem., 39: 635-45(Mar. 1961).

The fractional chain yields of Ga^{72}, Br^{82}, Ag^{112}, and La^{140}, formed in the proton-induced fission of Th^{232}, were measured at proton energies ranging between 12.8 and 82.4 Mev. The yields were compared with data previously obtained by others from uranium and thorium fission and with predictions made by Coryell. During the course of the investigation, the half life of Zn^{72} was checked and found to be 46.5 ± 0.1 hr, rather than 49 hr as previously reported. (auth)

13682 SEARCH FOR CORRELATIONS OF MOST PROBABLE NUCLEAR CHARGE Z_p OF PRIMARY FISSION FRAGMENTS WITH COMPOSITION AND EXCITATION ENERGY. Charles D. Coryell, Morton Kaplan, and Richard D. Fink (Massachusetts Inst. of Tech., Cambridge). Can. J. Chem., 39: 646-63(Mar. 1961).

The repartition of nuclear charge in fission has a narrower dispersion than almost any other property connected with the fission process. To a crude approximation the distribution of nuclear charge between light and heavy partners (L and H) leads to the most probable charges $(Z_p)_L$ and $(Z_p)_H$ displaced from the respective charges Z_A of β stability by the same amount for the two fragments (Glendenin rule of equal charge displacement (ECD), 1946). The existence of shell offsets in the Z_A vs. A function for different neutron- and proton-shell regions must be considered. All available data for thermal fission $U^{235}(n_{th},F)$ were examined critically. The data showed sudden offset-like drifts (fine structure) that may well be associated with shell properties of the products before the "neck" has dissolved. It is shown that these data eliminate naive ECD, also an older competitive prescription of constant charge ratio for the products, and an empirical Russian prescription (Apalin et al., 1960).

The data were also examined in the light of the postulate that fission gives minimum nuclear plus coulombic potential energy (Present, 1947; Fong, 1955; Swiatecki-Blann, 1960). It is shown that the present mass formulas do not provide a useful test when applied to the third and fourth β decays, because the uncertainty is too great, but that shell effects in masses must be retained. Data from charged-particle fission with energy deposit up to 40 to 50 Mev were in reasonable accord with the low-energy data on correcting for composition and neutron boil-off. It was concluded from experiment that Z_p is a single-valued function of A, known to about ±0.15 unit for low-energy fission and ±0.25 unit for medium-energy fission and that the fine structure very probably present is an indication of intrinsic nuclear chemistry. (auth)

13683 THE ATTACHMENT OF INERT GASES TO POWDERS FOLLOWING (n,γ) EVENTS. Roger Kelly (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 39: 664-74(Mar. 1961). (AECL-1165).

It was found that, when argon, krypton, and xenon are irradiated with neutrons in the presence of various powders, a portion of the inert-gas activity becomes "attached" to the powder. The attached activity was shown to be highly enriched and to be distinguishable from adsorbed activity. By expressing the attachment in terms of the attachment efficiency, A ≡ (inert-gas activity attached to target)/(total inert-gas activity), it was found that A was independent of irradiation time and neutron flux and for fine powders was also independent of pressures between 0.7 and 700 mm. The use of a very coarse powder or no powder at all led to a decrease in A; on this basis it was estimated that the maximum distance from a surface at which attached activity can originate is about 200 mean free paths. The following miscellaneous relations were observed to hold: $A \ll 1$, $A_{Ar} > A_{Kr} > A_{Xe}$, $A_{oxide} > A_{metal}$ (approximate). The results were, in general, consistent with a mechanism of attachment based on electrical attraction: inert-gas atoms first acquire a high charge due to vacancy cascades initiated by the conversion of capture gamma rays; they then wander about and, upon approaching a solid surface, are accelerated electrically into it. (auth)

13684 HALF-LIVES OF Rb^{94}, Sr^{94}, Y^{94}, Rb^{95}, Sr^{95}, Y^{95}. K. Fritze, T. J. Kennett, and W. V. Prestwich (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 39: 675-80(Mar. 1961).

The existence of a new rubidium isotope, Rb^{94}, was established and its half life measured. The half life of this fission product was determined by using the technique of timed precipitations. The value obtained for Rb^{94} was 2.9 ± 0.3 sec. With this same technique only an upper limit of 2.5 sec could be assigned to Rb^{95}. The half lives of the strontium and yttrium daughters were also determined. The strontium isotopes were studied both by timed precipitations and direct measurements. The half lives of Sr^{94} and Sr^{95} were found to be 1.36 ± 0.06 and 0.8 ± 0.15 min, respectively. Direct measurements led to half lives of 20.35 ± 0.20 min for Y^{94} and 10.9 ± 0.2 min for Y^{95}. (auth)

13685 HALF-LIFE OF Cs^{137}. H. Farrar, A. K. Dasgupta, and R. H. Tomlinson (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 39: 681-3(Mar. 1961).

The half life of Cs^{137} was found to be 30.4 ± 0.4 years by determining the amount of Ba^{137} produced in various times from a known number of Cs^{137} atoms. The numbers of barium and cesium atoms were determined from isotope-dilution data obtained with a mass spectrometer. (auth)

13686 SEARCH FOR THE (n,t) REACTION AT 14 Mev IN SOME MEDIUM WEIGHT NUCLEI. A. P. Baerg and G. C. Bowes (National Research Council, Ottawa). Can. J. Chem., 39: 684-8(Mar. 1961). (NRC-6140)

The (n,t) reaction at 14.6 Mev was observed to occur in S^{32} with a cross section of 4 ± 1 μb. Upper limits for the cross section of this reaction are also given for Ca^{40}, Cr^{50}, Fe^{54}, and Zn^{64}, and the results are discussed qualitatively in the light of recently reported (n,He^3) reactions. (auth)

13687 $Th^{232}(n,2n)Th^{231}$ CROSS SECTION FROM THRESHOLD TO 20.4 Mev. J. P. Butler and D. C. Santry (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 39: 689-96(Mar. 1961). (AECL-1180)

The excitation curve for the reaction $Th^{232}(n,2n)Th^{231}$ was measured by the activation method from the threshold energy, 6.34 Mev, to 20.4 Mev, relative to the known cross section for the $S^{32}(n,p)P^{32}$ reaction. Monoenergetic neutrons were obtained from the D(d,n)He^3 and T(d,n)He^4 reactions by employing a tandem Van de Graaff accelerator. From threshold to 9.0 Mev, the (n,2n) cross section rose rapidly, reaching its maximum value of 1.88 ± 0.09 barns in the region of 9.5 to 11.0 Mev. Above 11.5 Mev the (n,2n) cross section decrease owing to competition of the (n,3n) and (n,2nf) reactions, and at 20.4 Mev it had a value of 0.22_6 ± 0.01_6 barns. (auth)

13688 EVIDENCE FOR LOW-MOMENTUM-TRANSFER PROCESS IN $K^{41}(\alpha,n)Sc^{44m,g}$ REACTIONS FROM RANGE MEASUREMENTS OF PRODUCTS. Taku Matsuo and T. T. Sugihara (Clark Univ., Worcester, Mass.). Can. J. Chem., 39: 697-705(Mar. 1961).

Average forward ranges were measured for the product nuclides Sc^{43}, Sc^{44m}, and Sc^{44g} as produced in the reactions $K^{41}(\alpha,xn)$ with alpha particles in the energy region 23 to 39 Mev. These ranges, which were determined by a thick target–thick catcher technique, indicated that the (α,n)-produced isomers were formed in part by a low-momentum-transfer process above 30 Mev, its contribution being larger for the ground-state nuclide Sc^{44g}. From a thick target–thin catcher experiment at 40 Mev, it was found that the range distribution for Sc^{43} is that expected for a compound-nucleus reaction. Normalizing the Sc^{44m} and Sc^{44g} activity distributions to that of Sc^{43} for the catchers farthest from the target, lower limits were estimated for the contribution of a direct-reaction low-momentum-transfer process to the formation of Sc^{44m} and Sc^{44g} at 40 Mev to be about 30 and 46%, respectively. (auth)

13689 DETERMINATION OF THE DISINTEGRATION RATE OF NUCLIDES DECAYING BY ELECTRON CAPTURE. J. R. S. Drouin and L. Yaffe (McGill Univ., Montreal). Can. J. Chem., 39: 717-28(Mar. 1961).

In an attempt to determine disintegration rates of nuclides decaying by electron capture, various properties of a 2π proportional counter spectrometer were studied. These included gas multiplication, energy resolution, and energy linearity. The result of varying anode size, gas pressure, and nature of the gas was also investigated. An experimentally determined average path length for characteristic x-ray energies between 4 and 24 kev was found. (auth)

13690 COLLECTIVE MULTIPOLAR EXCITATION OF SOME ODD-ODD NUCLEI BY INELASTIC α SCATTERING. Jean Saudinos, René Beurtey, Phillippe Catillon, Robert Chaminade, Monique Crut, Henriette Faraggi, André Papineau, and Jacques Thirion. Compt. Rend., 252: 96-8 (Jan. 4, 1961). (In French)

A study of inelastic scattering (α,α') By Cu^{63}, Cu^{65}, and Fe^{57} shows the existence of two families of multiplets. They can be interpreted as being caused by the coupling of the celibate nucleon to the collective quadrupole and

octupole vibrations of the corresponding even-even core. (tr-auth)

13691 NUCLEAR MAGNETIC RESONANCE OF Tb^{159} IN POWDERED METALLIC TERBIUM IN THE FERROMAGNETIC STATE. Jacques Hervé and Pierre Veillet (Laboratoire d'Électronique et Radioelectricité de la Sorbonne, Fontenay-Aux-Roses, France). Compt. Rend., 252: 99-101(Jan. 4, 1961). (In French)

The nuclear magnetic resonance of powdered metallic Tb^{159} was measured at the temperature of liquid nitrogen in order that the terbium would be sharply ferromagnetic. The frequency range 2600 to 3200 Mc was investigated. In the vicinity of 3047 Mc a variation of the losses, having the form of an absorption ray, was observed in measurements at 77°K. The results obtained for the nuclear transition frequency are in good agreement with experiments on the hyperfine structure of Tb^{3+}. (J.S.R.)

13692 TOTAL CROSS-SECTIONS FOR THE NUCLEAR SCATTERING OF 765 MeV NUCLEONS. G. Z. Shah and B. M. Thaker (Bhavan's Coll., Bombay). Current Sci. (India), 29: 385(Oct. 1960). (In English)

The total cross sections, σ_t, for the scattering of 765-Mev nucleons by nuclei were calculated using the formula derived by Gatha and Shah. The absorption parameter $\bar{K}$ was calculated from the experimental values for $\sigma_{np} = 34.4$ mbn and $\sigma_{nn} = \sigma_{pp} = 45.0$ mbn. Theoretical and experimental values are given for nucleon scattering by lithium, carbon, oxygen, and aluminum. (M.C.G.)

13693 SCATTERING OF HIGH ENERGY ELECTRONS BY CARBON AND OXYGEN. L. V. Deshpande and V. B. Kelkar (Inst. of Science, Bombay). Current Sci. (India), 29: 385-6(Oct. 1960). (In English)

In studies of the scattering of high-energy electrons by carbon and oxygen, the form-factor $g(\bar{s})$ for cross-section values was expressed as $\bar{s}\, g(\bar{s}) = \int_0^\infty \bar{r}\rho(\bar{r}) \sin(\bar{s}\,\bar{r})d\bar{r}$, where $\rho(\bar{r})$ represents the density of protons in the nucleus and $\bar{r} = rA^{-1/3}$; $\bar{s} = sA^{1/3}$, and $s = 2K \sin(\theta/2)$. A plot of the variation of $g(\bar{s})$ with s at various values of electron energies showed that an identical characteristic density distribution $\rho(\bar{r})$ holds good for both carbon and oxygen. The curves appeared to coincide except in the region of large $\bar{s}$. The variation of $\rho(\bar{r})$ of carbon as a function of $\bar{r}$ is shown. (M.C.G.)

13694 STUDY OF RADIOACTIVE DECAY Tm^{168}. V. Brabec, B. Kracik, and M. Vobecky (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Prague). Czechoslov. J. Phys. 10: 969-70(1960). (In Russian)

Measurements were made on Tm^{168} (T = 87 days) containing Tm^{167} (T = 9.6 days), Tm^{166} (T = 7.7 hr), and Tm^{165} (T = 29 hr). Conversion lines with energies of 57, 208, and 536 kev were observed in the Tm^{167} spectrum; 9 conversion electron lines were observed in the Tm^{168} spectrum. The k-line (304 kev) observed in the Tm^{168} spectrum has not been observed previously. The boundary energy of the β spectrum ($E_0 = 940 \pm 20$ kev) was determined by a Fermi plot. The ratio of solid intensity spectra and conversion lines $I\,\beta/I_{L+M-80} = 0.45$ (44 days following the irradiation) considering the boundary energy also corresponds to the β^- energy of Tm^{170} (T = 129 days), there is a possibility that the solid spectrum belongs to Tm^{170}. In case the observed solid spectra belongs to Tm^{168}, then 81% of all decays in Tm^{168} belongs to electron capture and 19% to β^- decay, indicating a Tm^{168}/Tm^{170} yield ratio in deep tantalum spallation of 100 : 30. (R.V.J.)

13695 THE FINE STRUCTURE OF THE ENERGY SPECTRUM OF PHOTOPROTONS AND THE ENERGY LEVELS OF THE Li^6 NUCLEUS. A. P. Komar and E. D. Makhnovskiĭ (Inst. of Physics and Tech., Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 135: 52-4 (Nov. 1, 1960). (In Russian)

The energy distributions produced in (γ,p) and (γ,n) reactions in Li^6 at $E_{\gamma max} = 28$ Mev were determined. An 8.6-mg/cm^2 lithium foil containing 90% Li^6 was irradiated in a vacuum chamber. Protons were recorded by 400-μ-thick emulsions (NIKFI–Ya^2) placed at 60° to the photon beam. The energy distribution of protons was plotted, and the postulation that the reaction $Li^6(\gamma,n)Li^5 \rightarrow p + \alpha$ takes place in the ground state was confirmed. The reaction (γ,p), forming He^5 in an excited $3/2^+$ state at 16.7 Mev, is analyzed. It is shown that all the maximums with $E_p > 4$ Mev are related to γ resonance absorption followed by proton emission and production of He^5 in the ground state. The energy levels of Li^6 (5.5 and 11.6 Mev and unresolved peaks at 4.1 and 4.5 Mev), calculated considering the photon and the nuclear recoil, are tabulated. (R.V.J.)

13696 PHOTOFISSION OF Ne^{22}. A. P. Komar, Ya. Krzhemenek, and I. P. Yavor. Doklady Akad. Nauk S.S.S.R., 135: 291-3(Nov. 11, 1960). (In Russian)

Photofission of Ne^{22} was studied with a Wilson chamber placed in a constant magnetic field of 6700 gauss. The mixture of neon isotopes consisting of 89% Ne^{22}, 10% Ne^{20}, and 1% Ne^{21} was irradiated with a 90-Mev γ beam. The recorded relative yield of various photofission types and the energy thresholds of respective α reactions in Ne^{22} and Ne^{20} are tabulated. The ph f yield for Ne^{22} is 20 ± 3 mb/Q. Proton energy distributions in (γ,p) and (γ,pn) reactions and angular distributions of photoprotons of over 0.5 Mev from the above reactions are plotted. Proton emissions from Ne^{22} are followed by neutron emission in about 40% of the events, whereas the relative yield of (γ,pn) reaction for Ne^{20} is considerably less even though energy thresholds of these reactions are the same for Ne^{22} and Ne^{20}. Energy distributions of protons in (γ,p) and (γ,pn) reactions on Ne^{22} are close. A considerable number of high-energy protons (< 10 Mev) was observed in both cases. The relatively small yield of $(\gamma,\alpha p)$ reactions on Ne^{22} compared with Ne^{20} is discussed. (R.V.J.)

13697 DECAY OF Ho^{156}. E. P. Grigor'ev and B. S. Dzhelepov (Leningrad State Univ. and Khlopin Radium Inst., Academy of Sciences, USSR). Doklady Akad. Nauk S.S.S.R., 135: 564-7(Nov. 21, 1960). (In Russian)

The conversion spectrum of Ho^{156} with $T_{1/2} = 56$ min was studied with a double-focusing $\pi\sqrt{2}\,\beta$ spectrometer. Transition energies, multipolarity, and energy levels for Dy^{156} were determined. The data for Ho^{156} are tabulated, and the half life for the 366.7-kev transition was found to be 57 ± 3 min. The suggested decay scheme for Ho^{156} is given. The excitation of upper levels of Dy^{156}, which according to the semiempiric formulas is over 4 Mev, seems possible in Ho^{156} excitation. (R.V.J.)

13698 DECAY OF Lu^{168}, A TWO HOUR ISOTOPE. E. P. Grigor'ev, K. Ya. Gromov, B. S. Dzhelepov, V. Zvol'ska, A. V. Zolotavin, M. Veis, and Yung-yü Wang (Leningrad State Univ. and Joint Inst. for Nuclear Research, Dubna, USSR). Doklady Akad. Nauk S.S.S.R., 136: 325-8(Jan. 11, 1961). (In Russian)

Conversion lines with a period of 2 hr were found in lutetium products of tantalum irradiation by 660-Mev protons. A double focusing ($\pi\sqrt{2}$), 0.15% resolving power spectrometer was used to find the lutetium lines. Three conversion lines L_{II}, L_{III}, and N_I with the period 2.15 ± 0.20 hr at 87.5 kev were found. Correlations of the energy difference of $L_{III}-L_{II}$ and N_I-L_{III} with x-ray data show the transitions

took place in ytterbium. In Yb^{170} the L line of E_2 transitions at 84.19 kev have a spectrum identical to the L lines for 2-hr lutetium. Comparisons are made of the experimental ratios $L_I : L_{II} : L_{III}$ and the theoretical ratios for various γ transition multiplicities at 87.54 kev. A decay scheme developed for Lu^{168} is included. (R.V.J.)

13699 ENERGY LEVELS OF W^{182}. V. S. Gvozdev, L. I. Rusinov, and Yu. L. Khazov (Inst. of Physics and Tech., Academy of Sciences, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 24: 1445-8(Dec. 1960). (In Russian)

The K-shell internal conversion coefficients were determined for a series of γ transitions in W^{182} and the theoretical magnitudes of multiple transitions are tabulated. The excited W^{182} was produced by Ta^{182} β decay with $T_{1/2}$ = 111d. A $\pi\sqrt{2}$ β spectrometer was used in the experiment. Internal conversion electron spectra are plotted at 1080 to 1170 kev; 820 to 960 kev; and 14 to 23 kev. The decay scheme is included. (R.V.J.)

13700 STUDIES OF DECAY SCHEMES $Bi^{212} \rightarrow Po^{212}$ BY $\alpha-\gamma$ AND $\gamma-\gamma$ COINCIDENCES. Yu. P. Gangrskiĭ, G. M. Gusinskiĭ, and I. Kh. Lemberg (Inst. of Physics and Tech., Academy of Sciences, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 24: 1449-56(Dec. 1960). (In Russian)

The scheme of Po^{212} levels from the electron conversion of Bi^{212} is compared to the levels of Bi^{212} β decay. The schemes exhibit only two coincidence levels at 727 and 1800 kev. Three groups of α particles with 9.488-, 10.417-, and 10.536-Mev energies are emitted from the 727-, 1678-, and 1800-kev levels. The γ spectrum of Bi^{212} coinciding with α particles with E = 8.78 Mev was recorded. A 52-channel amplitude analyzer was used for recording the $\alpha-\gamma$ coincidence spectrum. The angular correlation of 786 to 727 and 1073 to 727 cascade γ quanta was studied in order to find the spins and transitions. (R.V.J.)

13701 RELATIVE INTENSITIES OF CONVERSION ELECTRONS OF Lu^{170} AND Lu^{172}. V. V. Tuchkevich, V. A. Romanov, and M. G. Iodko. Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 24: 1457-64(Dec. 1960). (In Russian)

The energy levels of Yb^{170} and Yb^{172} were studied in order to find the excited levels of even-even nuclei above 1 Mev. A double-focusing spectrometer with half-width lines 0.25 to 0.35% and solid angle 0.1 to 0.2% was used in measuring the relative conversion intensities in a lutetium fraction separated from a tantalum target which had been bombarded by 660-Mev protons. The transition energies, conversion line intensities, and conversion transition coefficients for Yb^{172} and Yb^{170} are tabulated, and the decay schemes of Lu^{172} and Lu^{170} are presented. (R.V.J.)

13702 CASCADE EXCITATION OF SECOND ROTATION LEVELS IN SEPARATED W ISOTOPES. D. S. Andreev, K. I. Erokhina, and I. Kh. Lemberg (Inst. of Physics and Tech., Academy of Sciences, USSR). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24: 1470-3(Dec. 1960). (In Russian)

Tungsten targets were bombarded with 27.8-Mev Ne^{20} ions and 36-Mev nitrogen ions, and the excitation levels in W^{182}, W^{183}, W^{184}, and W^{186} were determined. The γ spectra for W^{182} and W^{184}, bombarded by 27.8-Mev Ne^{20}, and W^{186}, bombarded by 36.0-Mev nitrogen, are shown. The magnitudes $E_{4^+ \rightarrow 2^+}$ for the transition $4^+ \rightarrow 2^+$ in W^{182}, W^{184}, and W^{186} are 230, 250, and 275 Mev, respectively. An analysis of the data confirms a postulation that γ lines E = 230, 250, and 275 kev are produced by Coulomb excitation at E = 330, 360, and 400 kev in W^{182}, W^{184}, and W^{186}, respectively. A second rotational level, E = 400 kev, was found in W^{186} for the first time; the rest of the data are in good agreement with published data and to a certain degree supplement them. (R.V.J.)

13703 COULOMB EXCITATION OF FIRST LEVELS IN EVEN–EVEN NUCLEI OF Cr, Se, AND Nd ISOTOPES. D. S. Andreev, A. P. Grinberg, G. M. Gusinskiĭ, K. I. Erokhina, and I. Kh. Lemberg (Inst. of Physica and Tech., Academy of Sciences, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 24: 1474-7(Dec. 1960). (In Russian)

New data are presented on the Coulomb excitation of even-even nuclei of chromium, neodymium, and selenium isotopes by nitrogen ions (E = 16.3 and 36.0 Mev) and neon ions (E = 23.2 Mev). The lifetime of the first level of Se^{78} ($\tau = 1.8 \pm 0.4 \times 10^{-11}$ sec) is in good agreement with published data obtained by As^{76} resonance γ scattering on selenium ($\tau = 1.3 \pm 0.2 \times 10^{-11}$ sec). For the first level in Nd^{144}, $\Delta E = 705 \pm 10$ kev, B(E2) is $\Delta E = 0.695$ Mev. The transition relation to neutron number in the nuclei holds good for both selenium and neodynium, i.e., the further the neutron number from the "magic" number, the more ΔE is reduced and the more B(E2) is increased. Cr^{52}(Z = 24) has 28 neutrons in a closed shell. Correspondingly, the first-level energy in Cr^{52}(ΔE = 1.45 Mev) is considerably larger than in Cr^{50} and Cr^{54} (ΔE = 0.780 and 0.840 Mev). It was also observed that the value B(E2) for the first Cr^{52} level coincides with that of Cr^{54}. (R.V.J.)

13704 COULOMB EXCITATION OF Ne^{21} NUCLEUS. D. S. Andreev, K. I. Erokhina, and I. Kh. Lemberg (Inst. of Physics and Tech., Academy of Sciences, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 24: 1478-9(Dec. 1960). (In Russian)

Coulomb excitation of the first level was studied in enriched Ne^{21}. At the target the current of tetravalent Ne^{21} (E = 24.2 Mev) was $\sim 5 \times 10^{-11}$ a. The magnitudes B(E2)↑ (in units $e^2\ 10^{-48}\ cm^4$) for the first levels were: Ne^{20} = 0.047, Ne^{21} = 0.025, and Ne^{22} = 0.039. A small dependence of B(E2) on the number of neutrons was observed. (R.V.J.)

13705 DETERMINATION OF Ga^{71}, Cu^{65}, and V^{51} L–X-RAY FLUORESCENCE COEFFICIENTS. A. A. Konstantinov, T. E. Sazonova, and V. V. Perepelkin (Mendeleev All-Union Research Inst. of Metrology, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 24: 1480-3(Dec. 1960).

A 4-π proportional counter filled with methane was used for determining the α x-ray fluorescence coefficients for Ga^{71} (Ge^{71}), Cu^{65} (Zn^{65}), and V^{51} (Cr^{51}). The data indicate that the magnitude ω_L for Ge^{71} (Ga^{71}) and Cr^{51} (V^{51}) coincides within an order of error (12 to 16%). (R.V.J.)

13706 STUDIES OF Te^{118} AND Te^{119} AND ENERGY LEVELS OF Sb^{119}. A. A. Sorokin, A. Bedesku, M. V. Klimentovskaya, L. N. Kryukova, K. P. Mitrofanov, V. V. Murav'eva, V. N. Rybakov, G. Chandra, and V. S. Shpinel. Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 24: 1484-91(Dec. 1960). (In Russian)

The γ spectrum and $\gamma-\gamma$ coincidences of neutron-deficient tellurium isotopes, prepared by 660-Mev proton bombardment, were measured with a scintillation coincidence spectrometer. The spectra were recorded with a 100-channel analyzer; the resolving time of the coincidence scheme was $2\tau = 2 \times 10^{-7}$ sec. A Fermi plot of the tellurium β^+ spectrum indicates one component with an upper boundary of 2700 ± 50 kev and a half life of 6.1 ± 0.1 days, assigned to the Te^{118} and Sb^{118}. The γ spectrum of tellurium, measured after 4 days, shows a region $E_\gamma > 700$ kev decaying at a half period of 4.75 ± 0.2 days, presumably Te^{119}. The level scheme of Sb^{119} excited in Te^{119} decay (T = 4.75) was plotted on the basis of $\gamma-\gamma$ coincidences. The most intense cascade was at 153 to 1220 kev. Cas-

cades of 271 to 950, 271 to 1100, and 153 to 950 kev were also found. The angular correlation of the 153 to 1220 kev cascade is expressed as $W(\theta) = 1 - (0.06 \pm 0.01) P_2 (\cos \theta) + (0.01 \pm 0.01) P_4 (\cos \theta)$. The ground state of Sb^{119} is of the $\frac{1}{2}^+$ type, while the multiplicity of the 153 to 1220 kev transitions indicates $\frac{1}{2}^+$ to $\frac{11}{2}^+$ for 1370 kev in Te^{119}. A decay scheme is suggested for Te^{119} (T = 12 hr). (R.V.J.)

13707 PROBABILITIES OF RADIATIVE TRANSITIONS BETWEEN THE ROTATION LEVELS OF Er^{166} AND Tm^{169} NUCLEI. E. E. Berlovich, V. V. Il'in, A. I. Kislyakov, M. K. Nikitin, and T. Bedike (Inst. of Physics and Tech., Academy of Sciences, USSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 24: 1492-1501(Dec. 1960). (In Russian)

The life-time of the first excitation level (81 kev) for Er^{166} and three levels (118, 139, and 473 kev) for Tm^{169} was studied with a coincidence spectrometer capable of measuring e-e, β-e, Auger-e, and Auger-Auger type coincidences (e is internal conversion electron and β is decay electrons). A semilog scale of decay curve is plotted for the first excitation state (2^+) of Er^{166} obtained by measuring the number of K electron coincidences of 184 kev (left branch) and M-electron conversions of 81 kev (right branch). The half life for Er^{166} was found to be $T_{\frac{1}{2}} = (2.0 \pm 0.2) \times 10^{-9}$ sec. The decay scheme for $Yb^{169} \rightarrow Tm^{169}$ is plotted for the 472.91-, 379.31-, 316.19-, 138.95-, 118.20-, and 8.4-kev lines, and spins and life times are assigned and correlated with published data. (R.V.J.)

13708 REACTIONS OF CARBON IONS WITH PHOTOEMULSION NUCLEI. L. I. Bolotin, A. P. Klyucharev, Yu. F. Kulygin, Yu. N. Ranyuk, E. I. Revutskiĭ, and I. Ya. Rutkevich (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 24: 1502-4(Dec. 1960). (In Russian)

Reactions of carbon ions with emulsion nuclei were studied. The emulsion consisted of a relatively small number of so-called "light" elements (carbon, nitrogen, and oxygen) and "heavy" elements (bromine and silver). The 110-Mev carbon ion beam passed a magnetic analyzer, was reduced by a diaphragm, and fell on the photoplate at 25° to the beam axis. Spallations emitting protons, α particles, and heavier fragments were observed. The data on carbon-ion-induced reaction, emitting various members of charged particles, shows an α-particle predominance in comparison to protons (from 1300 charged particles only 300 were protons or other singly charged particles). This predominance is explained by C^{12} spallation into three α particles at 7.3 Mev, less than half the bonding energy of the last neutron (18 Mev) and last proton (16 Mev) in the carbon nucleus. Previous studies indicate larger α-particle yields in emulsion irradiation by oxygen and nitrogen ions; six- and seven-prong stars being formed by binary charged particles. A star formed by a carbon and oxygen ion collision is analyzed. (R.V.J.)

13709 THE β STABILITY LIMITS AND β DECAY PERIODS. N. N. Kolesnikov and M. M. Kolesnikova (Moscow State Univ.). Izvest. Vysshikh Ucheb. Zavedeniĭ, Fiz., No. 2, 48-56(1960). (In Russian)

An analysis is made of total β-decay periods in the region $40 < A < 90$. The formula for β-decay probability and a generalized formula for nuclear masses are used for showing that, within the region of saturation of the same neutron and the same proton shell, the periods of β^-, β^+, and electron conversion decay are determined by a distance corresponding to the limit of energy stability. The derived formulas are correlated with experimental data. Diagrams are plotted of the half lives of various types of nuclei, and the possibility of evaluating the half lives of unknown nuclei is discussed. (tr-auth)

13710 COULOMB EXCITATION OF Au^{197} AND W^{186} BY PROTONS OF ENERGY UP TO 12.6 Mev. A. V. Cohen and J. A. Cookson (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nuclear Phys., 23: 32-9(Feb. 1961). (In English)

The excitation function is determined for inelastic scattering of protons with energies between 6.7 and 12.6 Mev from Au^{197}, exciting the 279- and the 548-kev levels. Results are compared with the predictions of semiclassical theory, and reasons for possible discrepancies are discussed. The 2+ nature of the 730-kev level in W^{186} is confirmed. (auth)

13711 THE OPTICAL MODEL AND DEUTERON STRIPPING. James E. Young (Los Alamos Scientific Lab., N. Mex.). Nuclear Phys., 23: 40-52(Feb. 1961). (In English)

A development is given which stresses the underlying similarity between the deuteron-stripping theory on the one hand and direct-interaction theory of inelastic nucleon scattering on the other. The assumption is that both formulations are given in distorted Born approximation. Some implications for the form of the stripping theory, e.g., construction of the distorting potentials, are discussed. The entire theory, as given, for the transition matrix element is first order in the two-body scattering operators. Probable corrections to this description, such as those arising from multiple scattering, are discussed. (auth)

13712 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF PROTACTINIUM-233. Richard Marrus, William A. Nierenberg, and Joseph Winocur (Univ. of California, Berkeley). Nuclear Phys., 23: 90-106(Feb. 1961). (In English)

By means of the atomic-beam magnetic-resonance method using radioactive detection, the hyperfine structure of $_{91}Pa^{233}$ ($T_{\frac{1}{2}} = 27.4$ days) is investigated. Three low-lying states are found in the beam, characterized by electronic angular momenta $J = \frac{11}{2}, \frac{9}{2}$, and $\frac{7}{2}$ and g values $g_J = -0.8141(4), -0.8062(15)$, and $-0.7923(15)$, respectively. From these results it is inferred that the ground-state configuration of protactinium is almost certainly $(5f)^2(6d)^1(7s)^2$. The nuclear spin is measured and found to be $I = \frac{3}{2}$, and the magnetic dipole and electric quadrupole hyperfine-structure coupling constants are measured to be $A = \pm 595(30)$ and $B = \pm 2400(300)$Mc, respectively. From a direct measurement the nuclear moment is found to be $\mu_I = +3.4(0.8)$ nm. From the hyperfine-structure constants and detailed calculations involving the electronic wave functions, the quadrupole moment is inferred to be $Q = -3.0$ barns. (auth)

13713 INVESTIGATION OF γ-RAYS FROM Mg^{24}, Mg^{25}, Mg^{26} ISOTOPES BOMBARDED WITH Po α-PARTICLES. E. Csongor (Inst. of Experimental Physics, Debrecen, Hungary). Nuclear Phys., 23: 107-15(Feb. 1961). (In English)

Magnesium isotopes Mg^{24}, Mg^{25}, and Mg^{26} are bombarded with polonium α particles. For Mg^{25} and Mg^{26} the excitation function of γ radiation from the nuclear processes is measured with a thin target. For the Mg^{25} target, resonances are found at α energies of 3.58, 4.33, 4.47, 4.61, 4.80, 4.99, and 5.09 Mev, and for the Mg^{26} target, at α energies of 4.56 and 5.01 Mev. From these data seven highly excited states of the Si^{29} compound nucleus and two of the Si^{30} nucleus are determined. The origin of γ radiation is cleared up by the observed spectra of γ rays. A method for a micro electrochemical deposition of magnesium is proposed. (auth)

13714 MEASUREMENTS OF NEUTRON SPECTRA FROM FISSION. T. W. Bonner (Rice Univ., Houston, Tex.). Nuclear Phys., 23: 116-21(Feb. 1961). (In English)

The neutron spectra from the fission of U^{235}, U^{233}, and Pu^{239} by thermal neutrons are measured by means of the sphere moderated neutron spectrometer. The spectra fit a Maxwellian distribution of the form $N(E) = \sqrt{E}e^{-E/\theta}$. The value of the energy parameter θ is found to be 1.332 ± 0.030 Mev in the case of U^{235} + n; the energies of the prompt neutrons from the fission of U^{233} and Pu^{239} are respectively 1.8 and 4.0% greater than the prompt-neutron energy from U^{235} fission. Experiments on the spontaneous fission of Pu^{240} and Cf^{252} give values of θ of 1.189 and 1.367 Mev. The most probable energy of the leakage neutrons from Jezebel is found to be 15% lower than that of Pu^{239} + n. The variation of the energy of fission neutrons with $\bar{\nu}$ is compared to evaporation theory. (auth)

13715 CROSS SECTION FOR THE $Be^9(n,\alpha)He^6$ REACTION. R. Bass, T. W. Bonner, and H. P. Haenni (Rice Univ., Houston, Tex.). Nuclear Phys., 23: 122-30(Feb. 1961). (In English)

The cross section for the reaction $Be^9(n,\alpha)He^6$ is measured for neutron energies from 3.9 to 8.6 Mev by counting the induced He^6 activity. The cross section falls smoothly from 93 mb at 4.0 Mev to 39 mb at 6.5 Mev and 32.5 mb at 8.5 Mev. (auth)

13716 PROMETHIUM-148. J. S. Eldridge and W. S. Lyon (Oak Ridge National Lab., Tenn.). Nuclear Phys., 23: 131-8(Feb. 1961). (In English)

Pm^{48} is produced by two methods, (n,γ) reaction on Pm^{147} and (p,n) reaction on enriched Nd^{148}. In both instances two activities are observed: 5.4d Pm^{148} and 41.8d Pm^{148}. The decay of these isomers is followed by use of ion chambers, beta counters, and gamma scintillation spectrometers. Gamma rays of 0.550, 0.910, and 1.460 Mev are found to be associated with the 5.4d isomer with abundances of 0.25, 0.13, and 0.20, respectively. A negatron of 2.5 Mev is associated with the 5.4d isomer with an abundance of approximately 55%. Gamma rays of 0.085, 0.180, 0.210, 0.290, 0.410, 0.550, 0.630, 0.730, 0.910, 1.01, and 1.46 Mev are found to be associated with the 41.8d isomer with relative abundances of 2, 6, 2, 14, 21, 100, 83, 38, 21, 21, and 2, respectively. (auth)

13717 ANGULAR DISTRIBUTIONS OF FAST PHOTONEUTRONS. Franca Tagliabue and J. Goldemberg (Universidade, São Paulo, Brazil). Nuclear Phys., 23: 144-52(Feb. 1961). (In English)

The angular distribution of photoneutrons from 13 elements is measured with the $Si^{28}(n,p)Al^{28}$ threshold detector, which is primarily sensitive to neutrons with more than 6 Mev. The angular distributions observed do not, within the errors, show a definite maximum at 90° as expected by dipole absorption of the photons, except for bismuth, lead, and gold. (auth)

13718 EXCITATION FUNCTION OF $Pr^{141}(p,n)Nd^{141}$ AT ENERGIES TO 11.1 Mev. J. Olkowsky, M. Le Pape, and I. Gratot (Centre d'Etudes Nucleaires, Saclay, France). Nuclear Phys., 23: 164-8(Feb. 1961). (In French)

The absolute (p,n) cross section of Pr^{141} is measured by the activation method at proton energies up to 11.1 Mev. The energy dependence agrees with that predicted by the optical model. (auth)

13719 ASYMMETRY IN DOUBLE MOTT SCATTERING AND ABSOLUTE VALUES OF BETA-ELECTRON LONGITUDINAL POLARIZATION. P. E. Spivak, L. A. Mikaelyan, I. E. (Ye.) Kutikov, and V. F. Apalin (Kurchatov Atomic Energy Inst., Moscow). Nuclear Phys., 23: 169-72(Feb. 1961). (In English)

This paper was previously abstracted from the original language and appears in NSA, Vol 15, abstract no. 10134.

13720 THE PHOTODEUTERON YIELD FROM 30 MeV BREMSSTRAHLUNG IRRADIATION. Bengt Forkman (Univ. of Lund, Sweden). Nuclear Phys., 23: 269-84(Feb. 1961). (In English)

An investigation of the (γ, d) reaction in sulfur, cobalt, and copper was made. Bremsstrahlung of 30-Mev maximum energy was used. The emitted charged photoparticles were deflected by a magnetic field and recorded in nuclear emulsions. The range and the orientation of the tracks in the emulsions were measured and the trajectories of the photoparticles were calculated backwards for protons, deuterons, and α particles. The intersection point of each trajectory with the target plane gave information about the kind of photoparticle that produces the track. The ratio R_{dp} between the (γ, d) yield and the (γ, p) yield was determined. No strong fluctuation in the ratio between the adjacent elements cobalt and copper was observed. The ratios found were all zero for the three elements sulfur, cobalt, and copper, with a standard deviation of 0.009, 0.012 and 0.018, respectively. A calculation based on the statistical model of the ratio R_{dp} was made. The ratios obtained are, within the limits of the errors, in agreement with the experimental results. (auth)

13721 COMPETITION BETWEEN THE PAIRING FORCE AND THE SPIN-ORBIT FORCE IN V^{51}. M. Umezawa (Univ. of Manchester, England). Nuclear Physics., 23: 296-304(Feb. 1961). (In English)

The effect of a pairing force on configuration mixing of spin-orbit partners is estimated. It is found that the effect is comparatively large near closure of the j−j subshells, and detailed results are obtained for the ground state of V^{51}. The calculated magnetic moment of V^{51} is considerably improved as compared with the pure j−j pairing result, but the M1 transition from the first excited state to this ground state still remains forbidden. (auth)

13722 SPECTROSCOPIC CALCULATION OF ENERGY LEVELS OF SOME TIN ISOTOPES. J. B. Sanders (Universiteit, Leiden). Nuclear Phys., 23: 305-11(Feb. 1961). (In English)

Energy levels of a series of isotopes of tin are calculated. Configuration mixing is taken into account. A reasonable fit with the experimental data is obtained, and mixing ratios for wave functions are found. (auth)

13723 ANGULAR CORRELATION IN $Be^9(p,\gamma)B^{10}$ AND THE STATES OF B^{10} AT 7.56 AND 5.16 MeV. N. W. Tanner and S. S. Hanna (Oxford Univ.). Nuclear Phys., 23: 319-26 (Feb. 1961). (In English)

A measurement was made of the angular correlation of γ rays from the 7.56-Mev state of B^{10} (the 1.084-Mev resonance of $Be^9(p,\gamma)B^{10}$). An asymmetry of 9% was found which indicates that the spin and parity of the 7.56-Mev state is $J^\pi = 0^+$. The consequence of such an assignment is that the 5.16-Mev state cannot be the second T = 1 state of B^{10}. It is suggested that the state at 4.77 Mev is the T = 1 state, despite the shift of 0.33 Mev from the expected position. A tentative assignment of $J^\pi = 1^+$, T = 0 is made to the 5.16-Mev state. (auth)

13724 CAPTURE AND INELASTIC SCATTERING OF PROTONS BY SILICON-30. A. C. L. Barnard, S. Bashkin, C. Broude, and C. E. Hornback (State Univ. of Iowa, Iowa City). Nuclear Phys., 23: 327-37(Feb. 1961). (In English)

The reactions $Si^{30}(p,\gamma)P^{31}$ and $Si^{30}(p, p'\gamma)Si^{30}$ were studied

in the range of incident proton energies from 1.0 to 4.25 Mev. Some measurements with Si^{28} were made. At E_p = 3.88 Mev, the yield curves suggest that the weak resonance seen with natural silicon targets is caused by Si^{30}, and not by Si^{28}. The capture reaction did not give useful information about spins and parities of P^{31} states, but the angular distributions of the γ rays following inelastic scattering led to assignments for 10 of these states. (auth)

13725 STRUCTURE OF THE GIANT RESONANCE IN THE $Al^{27}(p,\gamma)$ REACTION. Motoharu Kimura (Tohoku Univ., Sendai), Katsufusa Shoda, Naoshi Mutsuro, Tsutomu Tohei, Kazuo Sato, Kunishige Kuroda, Katsumi Kuriyama, and Toshimitsu Akiba. Nuclear Phys., 23: 338-44(Feb. 1961). (In English)

The variation of the cross section for $Al^{27}(p,\gamma_0 + \gamma_1)Si^{28}$ with proton energy from 7.5 to 14.7 Mev reveals the full structure of the giant resonance. Gamma-ray yields for transitions to the ground and first excited states of the product nucleus were measured using a large NaI(Tl) crystal spectrometer. The width of the giant resonance is of the order of 4 Mev, with many resonance peaks and possibly a splitting due to deformation. (auth)

13726 EXPERIMENTAL AND THEORETICAL REMARKS ON THE DOUBLE β-DECAY. G. F. Dell'Antonio (Northwestern Univ., Evanston, Ill.) and E. Fiorini. Nuovo cimento (10), 17: Suppl. No. 1, 132-93(1960). (In English)

The main features of the Fermi interaction necessary for an understanding of the theoretical problems connected with double β decay are summarized. The phenomenon of double β decay is discussed from both the theoretical and experimental point of view, taking into account the possible improvement of present results. Problems connected with the mass and structure of the nuclei are presented. Experimental results on double β decay are summarized. No conclusive evidence was obtained in favor of, or against, double β decay without emission of neutrinos. (M.C.G.)

13727 MÖSSBAUER EFFECT WITH Ni^{61}. Felix E. Obenshain and Horst H. F. Wegener (Oak Ridge National Lab., Tenn.). Phys. Rev., 121: 1344-9(Mar. 1, 1961).

The Mössbauer effect is observed in Ni^{61}. The Ni^{61*} was obtained by $Ni^{64}(p,\alpha)Co^{61} \xrightarrow{\beta^-\,(99\ min)} Ni^{61*}$, giving a nickel Mössbauer nucleus in a Ni^{64} host lattice. The magnitude of the effect at T = 80°K is about 4% for a 400 mg/cm^2 absorber foil (natural nickel). From the thickness dependence we obtain $f_{source} = f_{abs} = (9 \pm 1)\%$ is obtained for the Debye-Waller factor at 80°K. The temperature dependence yields a Debye temperature varying between 413 and 437°K. The velocity dependence has a half-width of 1.65 mm/sec. The spectrum deviates from the Lorentz shape expected for a single line. A recent electronic determination of the lifetime of this 71-kev state indicated a natural half-width of 0.37 mm/sec. The increased half-width and shape of the spectrum observed in this experiment may be understood in terms of a magnetic hyperfine splitting. The moment of the ground state was known. The internal field H and the magnetic moment μ_e of the first excited state are unknown. An analysis of the data gives a connection between the two quantities, $\mu_e(H)$. (auth)

13728 CHARGE DISTRIBUTION IN THE FISSION OF URANIUM ISOTOPES INDUCED BY 20-40 MEV HELIUM IONS. L. J. Colby, Jr. and J. W. Cobble (Purdue Univ., Lafayette, Ind.). Phys. Rev., 121: 1410-14(Mar. 1, 1961).

The primary yields of Br^{82}, I^{130}, La^{140}, Pr^{142}, and I^{135} were accurately determined for the medium-energy (20 to 40 Mev) helium-ion-induced fission of U^{233}, U^{235}, and U^{238}. These accurate primary yield data are correlated with the constant-charge-ratio rule for nuclides away from the neutron shells and give a smooth, but different, distribution curve for nuclides of 83 neutrons. (auth)

13729 HELIUM-ION-INDUCED FISSION CROSS SECTIONS OF U^{233} AND U^{238} AND THE NUCLEAR RADII OF HEAVY ELEMENTS. L. J. Colby, Jr., Mary LaSalle Shoaf, and J. W. Cobble (Purdue Univ., Lafayette, Ind.). Phys. Rev., 121: 1415-22(Mar. 1, 1961).

New radiochemical data of the total fission cross sections were obtained for U^{233} and U^{238}, which can be used to derive nuclear radii for these isotopes. These data and certain accurate previous results on U^{235} and natural bismuth can be interpreted in terms of an r_0 value of 1.41×10^{-13} cm, when $R_\alpha = 2.19 \times 10^{-13}$ cm, using the Weisskopf square-well nuclear model. Further, the nuclear radii obtained by this analysis are also in good agreement with the radii obtained from α-particle scattering data with a similar model. Certain features of the U^{233} fission curves are also discussed. (auth)

13730 ELASTIC SCATTERING OF POLARIZED 10-MEV PROTONS BY COMPLEX NUCLEI. L. Rosen, J. E. Brolley, Jr., and L. Stewart (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 121: 1423-37(Mar. 1, 1961).

A systematic investigation was carried out on the angular dependence of the polarization in the elastic scattering of 10-Mev protons by complex nuclei. Strong polarization effects, which vary smoothly with scattering angle and atomic number of target nucleus, appear to be a general feature of the scattering process. All the data are fitted reasonably well by a 5-parameter "optical model potential" (containing a spin-orbit term) in which the only variable is the $A^{1/3}$ dependence of the radius. The strength of the spin-orbit term required to account for the polarization is approximately the same as has been postulated in the shell model. (auth)

13731 (n,2n) EXCITATION FUNCTIONS OF SEVERAL NUCLEI FROM 12.0 TO 19.8 MEV. R. J. Prestwood and B. P. Bayhurst (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 121: 1438-41(Mar. 1, 1961).

(n,2n) excitation functions have been obtained for Sc^{45}, Ti^{46}, Ni^{58}, Cu^{65}, Ge^{70}, As^{75}, Rb^{85}, Rb^{87}, Sr^{84}, Y^{89}, Zr^{90}, Nb^{93}, Ag^{107}, In^{115}, Sn^{112}, Sb^{121}, Sb^{123}, Ta^{181}, Au^{197}, Tl^{203}, and Th^{232} at incident neutron energies of 12.00 to 19.76 Mev. The target elements were exposed to neutrons from the T(d,n) He^4 reaction in Zr–T and T_2 gas targets and the products were measured by radiochemical methods. (auth)

13732 NUCLEAR STRUCTURE STUDIES IN THE TIN ISOTOPES WITH (d,p) AND (d,t) REACTIONS. Bernard L. Cohen and Robert E. Price (Univ. of Pittsburgh). Phys. Rev., 121: 1441-56(Mar. 1, 1961).

The neutron single-particle states in the odd isotopes of tin are identified by (d,p) angular distribution studies. The cross sections for exciting these states by (d,p) and (d,t) reactions were measured, and the results were analyzed to give values of V_j^2 (in Kisslinger-Sorenson notation), the fraction by which each of the single-particle states is full, for each subshell in each isotope. These are used to calculate ϵ_j, the unperturbed single-particle energies; the results are reasonably consistent. If the observed energies of single-particle states are used to predict the V_j, the agreement is generally good, but some discrepancies are noted and an explanation is offered. Other weakly excited states are found in the region of the single-particle states. At higher excitation energies, several rather sharp levels are strongly excited in (d,p) reactions. Their energy, cross section, and regularities among the isotopes suggest that

these are single-particle levels from the next major shell ($82 < N \leq 126$); however, their angular distributions cannot be used for identification as they are the same for all levels in this region and show little structure. This last fact is not easily explained. Some of the two quasi-particle excitation states in the even isotopes of tin are identified and the apparent pairing energy is thereby measured; it is found to vary rapidly with mass number. Spectra from (d,p) and (d,t) reactions in isotonic pairs Cd^{114}–Sn^{116} and Cd^{116}–Sn^{118} are compared to show that the single-particle neutron states are much more radically affected by the addition of two protons than by the addition of two neutrons, contrary to the usual assumption in shell model theory. Q values for (d,p) and (d,t) reactions on the major isotopes of tin were measured. (auth)

13733 RANGE OF 2- TO 60-Kev RECOIL ATOMS IN Cu, Ag, AND Au. V. A. J. van Lint, R. A. Schmitt, and C. S. Suffredini (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev., 121: 1457-63(Mar. 1, 1961).

The ranges of atoms recoiling from photoneutron reactions in copper, silver, and gold were measured utilizing foil-sandwich irradiations followed by standard radiochemical detection techniques. Different energy spectra of recoil atoms were achieved by varying the bremsstrahlung energy and the angle of emission relative to the incident photons. The results are compared with calculations of Holmes and Leibfried. The best fit to the data was achieved by assigning values of the multiplicative parameter of the screening radius, α, equal to 1.7 for copper, 2.0 for silver, and 3.0 for gold. (auth)

13734 LIFETIMES OF EXCITED STATES OF NUCLEI WITH ODD MASS. R. E. Holland and F. J. Lynch (Argonne National Lab., Ill.). Phys. Rev., 121: 1464-71(Mar. 1, 1961).

The lifetimes of Coulomb-excited states in Ti^{47}, Mn^{55}, Fe^{57}, Zn^{67}, Ge^{73}, Se^{77}, and Mo^{95} were measured by a pulsed-beam technique. The observed mean lifetimes were between 0.1 and 12.7 mμsec. By combining these data with the measured Coulomb-excitation cross sections, the partial mean life was obtained for magnetic-dipole radiation and the ratio (E2/M1) for these transitions. The partial M1 lifetimes are 20 to 200 times as long as the single-particle estimates. (auth)

13735 RADIOCHEMICAL STUDY OF THE RANGES IN METALLIC URANIUM OF THE FRAGMENTS FROM THERMAL NEUTRON FISSION. James B. Niday (Univ. of California, Livermore). Phys. Rev., 121: 1471-83(Mar. 1, 1961). (UCRL-5816)

The mean ranges in uranium of 28 fission products were determined by radiochemical measurement of the fraction escaping from the surface. Several factors affecting the precision and accuracy of the method are discussed. A semi-empirical equation was developed which gives an excellent correlation between the ranges of fragments from a specific mass chain and their average initial velocity. The average total kinetic energy of the fragment pairs is about 30 Mev less for the products of symmetrical fission than is expected from comparison with the asymmetrical products. The low momenta of the symmetrical fragments are not readily explained by particle emission unless the concept of isotropic neutron evaporation is abandoned. The results may be interpreted by assuming that the symmetrical and asymmetrical products result from two modes of fission which involve different critical shapes of the fissioning nucleus, and that the choice between modes is dependent on the closing of the 50-proton shell in the heavy fragment. The 10% decrease in range observed for two shielded nuclides is also examined in some detail. (auth)

13736 MAGNETIC MOMENT AND HYPERFINE STRUCTURE COUPLING OF THE FIRST 2+ STATE IN Gd^{154}. Rae Stiening and Martin Deutsch (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 121: 1484-92(Mar. 1, 1961).

The g value of the 0.123-Mev 2+ state of Gd^{154} was found to be $g = 0.36 \pm 0.06$. The hyperfine structure constant of the same nuclear state in the $^8S_{7/2}$ ground state of Gd^{3+} in aqueous solution was determined as $a = 26.4 \pm 5$ Mc/sec. The perturbation of the angular correlation of γ-ray cascades proceeding through this state was studied. It was found that the perturbation in aqueous solution can be decoupled by magnetic fields either parallel to one of the γ rays or perpendicular to the plane of observation. The perturbation in molten $GdCl_3$ was found to be much weaker than in solution and to be unaffected by magnetic fields. Auxiliary measurements involving the first 2+ states in Sm^{152} and Gd^{156} are described. (auth)

13737 DECAY OF Hf^{180m}. W. F. Edwards and F. Boehm (California Inst. of Tech., Pasadena). Phys. Rev., 121: 1499-1503(Mar. 1, 1961).

The energies and relative intensities of the γ radiation and the relative intensities of the conversion electrons following the decay of 5.5-hr Hf^{180m} have been measured using the curved-crystal γ-ray spectrometer (recently calibrated for accurate intensity measurements), the ring-focused β-ray spectrometer, and the semicircular spectrometer at the California Institute of Technology. The measured transition energies are: 57.54 ± 0.01, 93.33 ± 0.02, 215.25 ± 0.13, 332.5 ± 0.3, and 443.8 ± 0.6 kev. The energy levels deduced from these values are not entirely consistent with the two-parameter rotational formula. Conversion coefficients derived from the measurements are absolutely normalized using a method involving information available from the decay scheme. All of the 57.54-kev transition conversion coefficients are anomalously high if compared with the theoretical E1 coefficients. No admixture of M2 + E3 can account for the anomaly. The K conversion coefficients of the E2 transitions are all about 10% low with exception of the 93.33-kev transition. The L coefficients have a varying deviation, the maximum being 12%. The K conversion coefficient of the 501.3-kev transition has the value 0.037 ± 0.012, which is consistent with the theoretical E3 value of 0.040. (auth)

13738 $Si^{28}(p,p'\gamma)$ ANGULAR CORRELATIONS. H. F. Bowsher, G. F. Dell, and H. J. Hausman (Ohio State Univ., Columbus). Phys. Rev., 121: 1504-8(Mar. 1, 1961).

Angular correlations have been measured between protons scattered inelastically from a Si^{28} target and the decay γ rays from the 1.78-Mev first excited state of the target nuclei. The incident proton bombarding energy varied between 5.8 Mev and 7.0 Mev. The angular correlation experiments were performed for proton detector angles of 37°, 60°, 90°, and 120°. The measured angular correlation functions are all of the form $A + B \sin^2[2(\theta - \theta_0)]$, where θ_0 is the axis of symmetry. When the incident proton beam energy was 7.0 Mev the symmetry direction was found to be 90° (center of mass), independent of the proton detector angle. These results agree with the prediction of a compound-nucleus theory. This suggests the existence of a strong compound nucleus resonance in P^{29} at an excitation energy of 9.6 Mev. For lower proton beam energies, the symmetry direction θ_0 shifts with a change in the proton detector angle or a change in the proton beam energy. These results are consistent with a direct-reaction mechanism. (auth)

13739 BETA EMISSION FROM ORIENTED ^{160}Tb AND ^{166m}Ho NUCLEI. H. Postma, M. C. Eversdijk Smulders,

and W. J. Huiskamp (Kamerlingh Onnes Laboratorium, Leiden). Physica, 27: 245-59(Feb. 1961). (In English)

Experiments on the directional distribution of β-particles emitted from oriented Tb^{160} and Ho^{166m} nuclei are reported and discussed. An asymmetry of about $-(v/c)f_1$ of the β-emission from polarized Tb^{160} nuclei was found. In the case of polarized Ho^{166m} nuclei an asymmetry of about -8% was detected. No anisotropy of the β-emissions from aligned Tb^{160} and Ho^{166m} nuclei was found. It is concluded that the groundstate of Tb^{160} has spin and parity 3-. In the case of Ho^{166m} several possibilities of spin and parity are rejected on the basis of the experimental results. Spin and parity of Ho^{166m} are probably 6-. Some considerations on the basis of the unified model are given. (auth)

13740 LOW ENERGY PROTON CAPTURE RESONANCES IN THE CHLORINE ISOTOPES. J. Kuperus (Rijksuniversiteit, Utrecht). Physica, 27: 273-6(Feb. 1961). (In English)

A search was made for proton capture resonances in the chlorine isotopes, making use of natural and enriched targets. Eighteen resonances were observed in the proton energy region from 300 to 900 kev, and their isotopic assignment was established from a comparison of the yield curves. Single gamma-ray spectra were recorded at all resonances. The characteristic lines observed in the spectra confirmed the isotopic assignment, made from the yield curves. Gamma-ray yields are given in absolute measure. Branching ratios were measured for transitions to known Ar^{36} and Ar^{38} levels. (auth)

13741 MEASUREMENTS OF MULTIPLE SCATTERING ON 10 BEV PROTON TRACKS. I. Ya. Chasnikov, Zh. S. Takibaev, R. A. Tursunov, and K. V. Sharapov (Inst. of Nuclear Physics, the Academy of Sciences, Kazakh SSR.). Pribory i Tekh. Ekspt., No. 5, 15-19(Sept.-Oct. 1960). (In Russian)

Various methods for determining the energy of charged particles by measuring multiple scattering in nuclear emulsions at variable ratios of Coulomb and pseudo-scatterings are analyzed. Data are given on the pseudo-scattering determined by various independent methods. The magnitude of pseudo-scattering resulting from emulsion microdistortions increases with the length of the cell according to the $0.08t^{0.6}$ law. The contribution of pseudo-scattering to the ~10 Bev proton scattering on t = 4 mm cells is negligible. (tr-auth)

13742 SELF-CONSISTENT FIELDS WITHOUT EXCHANGE FOR Pr^{3+} AND Tm^{3+}. E. Cicely Ridley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Cambridge Phil. Soc., 56: 41-54(Jan. 1960).

Self-consistent fields without exchange were calculated for the ground states of Pr^{3+} and Tm^{3+}. The spin-orbit coupling constant ζ(4f) was found to have the values 785 and 2742 cm^{-1} in Pr^{3+} and Tm^{3+}, respectively. The corresponding values of $(1/r^3)$ are 29.4 and 77.5A^{-3}. Values of the Slater integrals F^2(4f, 4f), F^4(4f, 4f), and F^6(4f, 4f) are also given for each structure. (auth)

13743 THE PHOTOPRODUCTION REACTION $^{60}Ni(\gamma,\pi^-)^{60}Cu$. P. V. March and T. G. Walker (Univ. of Glasgow). Proc. Phys. Soc. (London), 77: 293-8(Feb. 1, 1961).

The cross section for the reaction Ni^{60} (γ,π^-) Cu^{60} was measured using bremsstrahlung having maximum energies from 120 to 320 Mev. Radiochemical separation techniques were used to separate the Cu^{60} from the other activities produced by the irradiation. Results indicate that the reaction is due predominantly to surface production. (auth)

13744 INTERNAL CONVERSION OF ^{141}Ce. J. R. Cook (The Middlesex Hospital Medical School, London). Proc. Phys. Soc. (London), 77: 346-9(Feb. 1, 1961).

The K conversion coefficient of the 141-kev γ ray of Ce^{141} was measured by a scintillation spectrometer as 0.405 ± 0.01. This indicates that the radiation is probably electric quadrupole. (auth)

13745 ABSENCE OF DOPPLER SHIFT FOR GAMMA RAY SOURCE AND DETECTOR ON SAME CIRCULAR ORBIT. D. C. Champeney and P. B. Moon (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 77: 350-2(Feb. 1, 1961).

An experiment is described showing that for a source and absorber of Fe^{57} placed at opposite ends of a rotor, the Mössbauer absorption is unaffected by rotation. This is contrary to the situation with the source at the center when relativistic effects cause a frequency shift between source and absorber. (auth)

13746 GAMMA RAYS CORRESPONDING TO A DIPOLE OR A HIGH QUADRUPOLE EXCITATION OF CARBON 12 BY 150 MeV PROTONS. N. Gilbert (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 77: 362-76(Feb. 1, 1961).

The process $C^{12}(p,p'\gamma)C^{12}$ is formulated in direct interaction theory using the sum rule for the group of dipole states at about 20 Mev and for a group of quadrupole states that are assumed to be at about 30 Mev. The angular correlation (p',γ) is discussed and it is shown that for some (p',γ) and (p,p') angles the emission of an E2 γ ray in this range of energy has an appreciable probability. (auth)

13747 A STUDY OF THE REACTIONS $^{12}C(^3He,n)^{14}O$ AND $^{16}O(^3He,n)^{18}Ne$. J. H. Towle and B. E. F. Macefield (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Proc. Phys. Soc. (London), 77: 399-416 (Feb. 1, 1961).

The time-of-flight and slow-neutron threshold techniques in conjunction with He^3 particles of energies of up to 11 Mev, were used to measure the Q value of the $O^{18}(He^3,n)$ Ne^{18} reaction and to locate levels in O^{14} and Ne^{18}. The Q value, -3.199 ± 0.006 Mev, requires a mass defect of 10.649 ± 0.008 Mev for Ne^{18}. Levels were found in O^{14} at 5.905 ± 0.012, 6.30 ± 0.03, and 6.586 ± 0.012 Mev and in Ne^{18} at 1.880 ± 0.010, 3.362 ± 0.011, and 3.608 ± 0.012 Mev. Excitation functions are measured between 2.0 and 5.7 Mev for both reactions. Angular distributions of the $C^{12}(He^3,n)$ reaction measured at 4.65, 4.98 and 5.26 Mev, are compared with theory for a double stripping process. The data suggest that a direct process is competing strongly with compound nucleus formation in this energy region. (auth)

13748 THE REACTION $^{51}V(\gamma,\alpha)^{47}Sc$ AND SOME REMARKS ON (γ,α) REACTIONS. J. H. Carver (Australian National Univ., Canberra). Proc. Phys. Soc. (London), 77: 417-23(Feb. 1, 1961).

The $V^{51}(\gamma,\alpha)Sc^{47}$ reaction was studied using induced radioactivity techniques up to γ-ray energies of 32 Mev. The cross section had a maximum value of 0.95 mb at an energy of 22 Mev and an integrated cross section to 32 Mev of 12 ± 2 Mev mb. The statistical model gives a satisfactory interpretation of the ratio of the $V^{51}(\gamma,\alpha)$ cross section to the $V^{51}(\gamma,n)$ cross section. This interpretation can probably be applied to the (γ,α) yields from other middleweight nuclei, but it is not appropriate for the heavy nuclei ($Z > 50$). The roughly constant (γ,α) yields observed in the heavy nuclei may arise from direct electric dipole interactions with preformed alpha particles in the nuclear surface. (auth)

13749 POLARIZATION OF PROTONS FROM LOW RESONANCES IN $^{12}C(d,p)^{13}C$. A. G. Gregory and P. B. Treacy (Australian National Univ., Canberra). Proc. Phys. Soc. (London), 77: 499-507(Feb. 1, 1961).

The polarization of protons from the $C^{12}(d,p)C^{13}$ reaction was measured at deuteron energies from 790 to 1100 kv at angles of 45, 60, 90, 120, and 135°, using a carbon polarimeter. Published angular distributions were analyzed in conjunction with the present results in terms of compound nucleus theory. Previous assignments of 1^+ and 2^- for the first two resonance levels are confirmed. Analysis of the present results imply a ratio of reduced width amplitudes for d to s wave deuterons larger than that suggested by previous measurements of the angular distribution. However, in fitting these results, it was necessary to assume phase angles other than those required in the usual theory of resonance reactions. (auth)

13750 ACTIVATION CROSS SECTIONS WITH 14 MeV NEUTRONS. S. K. Mukherjee, A. K. Ganguly, and N. K. Majumder (Saha Inst. of Nuclear Physics, Calcutta). Proc. Phys. Soc. (London), 77: 508-14(Feb. 1, 1961).

Some activation cross sections were measured for the elements Na, Al, Sc, Cr, Cu, Ag and Bi using 14.8 Mev neutrons from the (DT) reaction. The cross sections were measured in relation to 556 mb for the cross section of $Cu^{63}(n,2n)Cu^{62}$ and 117 mb for the cross section of $Al^{27}(n,\alpha)Na^{24}$ reactions. (auth)

13751 UPPER LIMITS FOR THE RADIATIVE CAPTURE CROSS SECTIONS OF ^{27}Al AND ^{31}P FOR ^{16}O IONS. R. F. Coleman, D. N. Herbert, and J. L. Perkin (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Proc. Phys. Soc. (London), 77: 526-30(Feb. 1, 1961).

The radiative capture cross sections of Al^{27} and P^{31} for O^{16} ions with energies a few Mev above the expected thresholds for these reactions (~30 Mev) were not greater than 0.2 and 18 μb, respectively. Activation methods were used and care was taken to avoid errors due to impurities in the targets and the recoil into the targets of reaction products from elsewhere in the irradiation assembly. A calculation based on the statistical theory of the compound nucleus predicts a cross section of 2 μb for the capture in aluminum of O^{16} ions at the energy used in these experiments. Various possible reasons for this over-estimation of the cross section are discussed. (auth)

13752 ON HIGH ENERGY CHARGE EXCHANGE COLLISION. Toshinori Takemiya and Yoshiyuki Sakamoto (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 24: 1123-5 (Nov. 1960). (In English)

The quasi-elastic charge exchange reaction $C^{12}(p,n)N^{12*}$ is considered, in which N^{12*} is an excited N^{12} nucleus. The polarization and asymmetry of the ejected neutrons are measured as functions of incident proton energy in the range 70 to 310 Mev and as functions of the scattering angles. The transition matrix for the reaction is given in the impulse approximation. The coefficients of the scattering spin matrix are calculated by means of the two-body scattering phase shifts derived from the Gammel-Thaler nuclear potential. It is noted that the quasi-elastically ejected neutrons must be observed in "coincidence" with the deformation of the residual excited nucleus. (T.F.H.)

13753 ENERGY SPECTRUM OF NUCLEI NEAR Pb^{208} (PART I)—Pb^{205} AND Pb^{204}. Yü Tsuan-tsan, Hu T'ang-shih, Ch'eng Hsiao-t'ien (Inst. of Atomic Energy, the Academy of Sciences, Chinese People's Republic). Wu Li Hsüeh Pao 16: 1-10(1960). (In Chinese)

The energy levels of Pb^{205} and Pb^{204} were determined using the independent particle model and considering the two-body interaction as the perturbation effect and disregarding the internucleon bond exceeding three nucleons. The results are in good agreement with the experiment. (tr-auth)

13754 ENERGY SPECTRA OF NUCLEI NEAR Pb^{208} (PART II)—Bi^{208} AND Bi^{207}. Huang Wêng-chih, Liang Ch'ung-t'ien, Chou Kuang-Wêng, Yü Yu-Wêng, Chang Chung-huang, and Yü Ming (Inst. of Atomic Energy, the Academy of Sciences, Chinese People's Republic). Wu Li Hsüeh Pao, 16: 11-24(1960). (In Chinese)

The model of independent particles and perturbation methods were used in the investigation of the Bi^{208} and Bi^{207} energy spectra. The derived data on the Bi^{208} and Bi^{207} energy levels are in good agreement with experimental data. (tr-auth)

13755 ENERGY SPECTRA OF NUCLEI NEAR Pb^{208} (PART III). Pb^{208} AND Tl^{208}. Jêng Kêng-Wen, Chou Kuang-Wêng, Yu Yu-Wêng, Chang Ch'ung-hua and Yu Min (Inst. of Atomic Energy, the Academy of Sciences, Chinese People's Republic). Wu Li Hsüeh Pao, 16: 25-35(1960). (In Chinese)

A method of wave analysis was used in the investigation of Pb^{208} and Tl^{208} energy spectra. The results are in good agreement with the experiments. The first excited level 3^- was considered to be the surface oscillation of the third order 3^-. Calculations are made of some Bi^{207} and Pb^{206} levels. (tr-auth)

13756 γ TRANSITIONS NEAR Pb^{208} (PART I)—E2 AND E3. Liang Chung-t'ien, Hu T'ang-Shih, Ch'êng Hsiao-tien, Yu Yu-weng, and Yü Min (Inst. of Atomic Energy, the Academy of Sciences, Chinese People's Republic). Wu Li Hsüeh Pao, 16: 36-44(1960). (In Chinese)

Certain transition probabilities were evaluated by means of configuration methods and nuclear surface oscillations. Selected parameters $C_2 \sim 1000$ Mev, $C_3 = 350$ Mev, $\hbar\omega_3 = 2.6$ Mev, and $\hbar\omega_2 = 5$ Mev were used. Except for two transitions, E3 Pb^{206} the results are in good agreement with experimental data. It is shown that the configuration is induced by the residual interaction. Configurations of hardness and frequency determine the probability of the E2 and E3 transition. (tr-auth)

13757 GAMMA TRANSITION NEAR Pb^{208} (PART II)—M1. Huang Wêng-chih, Yü Tsyung-tsang, Kuo Ch'in, Chang Chung-hua, and Yü Min. (Inst. of Atomic Energy, the Academy of Sciences, Chinese People's Republic). Wu Li Hsüeh Pao, 16: 45-55(1960). (In Chinese)

The configuration method was used in the detailed analysis of M1 Pb^{205} transition. The results are in good qualitative agreement with the experimental data. All theoretical levels not observed in the experiment are analyzed. (tr-auth)

13758 MUON CAPTURE IN He^3 NUCLEUS. Chu Chia-chen, Chou Kuang-chao, and Peng Hong-an (University of Peking, China). Wu Li Hsüeh Pao, 16: 61-9(1960). (In Chinese)

The rate of the muon capture reaction $\mu^- + He^3 \rightarrow H^3 + \nu$, the angular distribution, and the polarization of the final nucleus H^3 were calculated based on the universal V—A coupling with an induced pseudoscular term and including a weak magnetic current. A general initial condition with polarized muon and polarized He^3 nucleus in different hyperfine states was assumed. The ground state wave function was assumed to be a pure S-state. The contribution of other states, which may be caused by the presence of tensor force or other velocity dependent forces was neglected. Meson exchange current was also neglected. Under these assumptions it was proved that the capture amplitude contains only one unknown nuclear matrix element, which is the Fourier transform of the nuclear density function. The

determination of this nuclear matrix element by the scattering of electrons (or muons) with He^3 (H^3) nuclei is proposed. (auth)

13759 ON THE SIGN OF THE EFFECTIVE PSEUDOSCALAR TERM IN μ-CAPTURE REACTIONS. Chou Kuang-chao and Huang Nien-ning (University of Peking, China). Wu Li Hsüeh Pao, 16: 70-5(1960). (In Chinese)

Recent experiments indicate that the sign of the effective pseudoscalar term in μ-capture reactions is different from the theoretical result of Goldberger and Treiman, based on V–A theory and dispersion relation technique. A possible explanation of this difference is proposed. It is shown that a very small pseudoscalar term in the Hamiltonian (of the order 1/100 of the effective pseudoscalar term) can change the sign of the effective pseudoscalar term. If this small term is transformed and added as a part of the universal axial vector current, it produces practically no effect in β and $\pi \rightarrow \mu + \nu$ decay. The inclusion of hyperon pairs was also considered. (auth)

13760 THE EFFECT OF RECOIL ON THE SCATTERING OF μ-MESONS BY LIGHT NUCLEI. Chou Kuang-chao (Peking University, China) and Dai Yuen-ben. Wu Li Hsüeh Pao, 16: 76-80(1960). (In Chinese)

The correction of the recoil to the potential in the scattering of μ mesons (or electrons) by zero-spin nuclei was derived by means of a simple method. The potential obtained was corrected to first order in the velocity of the nuclei but without restriction on the velocity of the μ mesons (or electrons). The effect of recoil on the phase-shifts and cross sections is discussed. The results are compared with those of Foldy, Ford, and Yennie. (auth)

13761 DECAY SCHEME OF Ag^{110m}. Ho Shen (Research Institute of Atomic Energy, China). Wu Li Hsüeh Pao, 16: 86-93(1960). (In Chinese)

The γ rays emitted in the decay of Ag^{110m} were studied by use of γ spectrometer and γ–γ coincidence techniques. Fourteen γ rays were found with energies of 448, 620, 656, 679, 705, 741, 764, 817, 884, 936, 1384, 1473, 1504, and 1560 kev. All these γ rays could be fitted into seven excited levels in Cd^{110} at 656, 1473, 1540, 2160, 2219, 2476, and 2924 kev. The generally accepted cascade relation between γ rays was verified. Furthermore, coincidence measurements showed that the 1560-kev γ ray is emitted during the transition between the 2219-kev level and the 656-kev level, that the 817-kev γ ray belongs to the transition between the 1473-kev level and the 656-kev level, and that the 764-kev γ ray should precede the 1504-kev γ ray. A modified decay scheme is proposed. (auth)

13762 BETA AND GAMMA EMISSION FROM ORIENTED NUCLEI. H. Postma. Groningen, Netherlands, J. B. Wolters, 1960. 127p.

The angular distributions of β and γ radiations emitted in a number of β and positron decays of oriented nuclei were measured. The observation of the asymmetry of the directional distribution of positrons emitted from polarized Co^{58} confirmed parity nonconservation in positron emission. The asymmetry of positrons emitted by polarized Mn^{52} was also determined. The beta decay of Ho^{166m} was studied by determining the anisotropies and linear polarizations of its γ radiation. The β spectra of oriented Ho^{166m} and Tb^{160} nuclei were also studied; Ho^{166m} and Tb^{160} are assigned as 6– and 3–, respectively. A discussion of the theory of β decay is given in which the two-component neutrino and universal VA theories are presented. Strongly deformed nuclei are considered, and coupling of the last odd proton and odd neutron in odd-odd nuclei and transition probabilities of β decays of even A nuclei are discussed. (D.L.C.)

13763 THEORETICAL ASPECTS OF THE MÖSSBAUER EFFECT. J. van Kranendonk (Univ. of Toronto). p.9-20 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A review is presented of theoretical work done in connection with the Mössbauer effect. The topics covered are: Principle of Recoil-less Transitions, Quantum Theory of the Mössbauer Effect, Classical Theory of the Mössbauer Effect, Frequency Shifts Suffered by the Mössbauer Line, and Hyperfine Structure Effect . (T.R.H.)

13764 NUCLEAR ORIENTATION. N. Kurti (Clarendon Lab., Oxford). p.156-63 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A discussion, limited to equilibrium orientation methods, is presented, beginning with the directional effects in radiation emitted to an assembly of oriented nuclei including γ, β, α, and fission fragments. The other papers of the present conference are then discussed as concerning nuclear physics and pexophysics. (T.R.H.)

13765 NUCLEAR ORIENTATION OF Tb^{156}. C. A. Lovejoy and D. A. Shirley (Univ. of California, Berkeley). p.164-6 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Tb^{156} from Gd^{156}(p,n) reactions was grown into crystals of neodymium and yttrium ethylsulfate. The Tb^{156} nuclei were aligned by adiabatic demagnetization of the crystal, and the γ rays were observed with scintillation counters and 100-channel pulse-height analyzers. For the nuclear moments, values of $|\mu|_{156} = 1.53 \pm 0.30$ nm and $Q_{156} = +1.8 \pm 0.5$ barns were obtained in close agreement with values predicted on the collective nuclear model. (T.R.H.)

13766 EFFECT OF MAGNETIC INTERACTIONS ON THE NUCLEAR ORIENTATION OF COBALT-60 IN CERIUM ZINC NITRATE. M. W. Levi, R. C. Sapp, and J. W. Culvahouse (Univ. of Kansas, Lawrence). p.168-71 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

An experimental study was made of the effects of Ce-Co magnetic interaction on the degree of nuclear orientation attained at very low temperatures by magnetic hfs coupling. Co^{60} nuclei were aligned in single crystal spheres of $Ce_2Zn_3(NO_3)_{12} \cdot 24H_2O$ that was cooled below 1°K by adiabatic demagnetization. In one sample the cobalt ions were spatially separated from the cerium ions, effectively breaking the magnetic interactions. It is concluded that this breaking removed the peculiar temperature dependence of ϵ and confirmed the hypothesis that Ce-Co interaction is the cause. A simple model for the interaction is offered. (T.R.H.)

13767 ALPHA-PARTICLE EMISSION FROM ORIENTED Np^{237}. J. W. T. Dabbs, S. H. Hanauer, L. D. Roberts, F. J. Walter, and G. W. Parker (Oak Ridge National Lab., Tenn.). p.177-80 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The spin Hamiltonian for Np^{237} in $NpO_2Rb(NO_3)_2$ having been established, measurements were made of the α-parti-

cle distribution to 0.2°K to determine unambiguously the signs of A and P. A germanium surface-barrier α counter was used. $A < 0$ and $P > 0$ is the correct choice, giving a calculated population of states at 0.2°K of $I_z = \pm 1/2$, 40.4%; $\pm 3/2$, 35.9% and $\pm 5/2$, 23.7%. The alignment, therefore, is predominantly perpendicular to the c-axis of the crystal, and the conclusion that the α particles are emitted preferentially along the angular momentum vector of the emitting nucleus is established. (T.R.H.)

13768 EXPERIMENTS ON THE BETA AND GAMMA EMISSION FROM ORIENTED Ho^{166m} AND Tb^{160} NUCLEI. H. Postma and W. J. Huiskamp (Kamerlingh Onnes Laboratorium, Leiden). p.180-3 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Experiments were performed on the anisotropy and linear polarization of γ rays emitted from aligned Ho^{166m} nuclei in a single crystal of neodymium ethylsulfate. Also measurements were made on the β emission from polarized and aligned Ho^{166m}. An assignment of 6− is most likely, but 7+ cannot be completely rejected. The anisotropy of the 960 to 964-kev γ from oriented Tb^{160} nuclei in neodymium ethylsulfate was measured vs. temperature and vs. magnetic field along the c-axis. The β decay contains mainly two intense components: 575 kev, probably allowed; and 870 kev, probably once forbidden. The β asymmetry of both is nearly optimal. (T.R.H.)

13769 BETA EMISSION FROM POLARIZED Co^{55}, Mn^{56}, AND Pr^{143}-NUCLEI. H. Postma and W. J. Huiskamp (Kamerlingh Onnes Laboratorium, Leiden). p.183-6 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Polarized sources of Co^{55}, Mn^{56}, and Pr^{143} grown into thin layers on CeMg nitrate single crystals, were obtained by hfs polarization below 1°K. Beta asymmetry, A, and 0.935-Mev γ intensity measurements for Co^{55} indicate $\Delta I = -1$. A for Mn^{56} was + showing that the β^- particles are emitted preferably antiparallel to nuclear spin. If Mn^{56} has spin = 3, then theoretical $A = f_1\, v/c \approx 0.5$ disagrees with experiment. If I = 2, the experimental results could be fitted to theory by assuming a mixture of GT and Fermi interaction. A is + for Pr^{143}, and a β anisotropy along the c-axis was observed. (T.R.H.)

13770 THE ANGULAR DISTRIBUTION OF BETA PARTICLES FROM ORIENTED CERIUM-141 NUCLEI. D. D. Hoppes (National Bureau of Standards, Washington D. C. and Catholic Univ. of America, Washington, D. C.). p.186-8 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Polarization measurements with Ce^{141} were made in connection with the investigation to see if β angular distribution with respect to nuclear spin direction $W(\theta) = \Sigma_n a_n f_n p_n(\cos\theta)$ provides information on the nuclear matrix elements in the first-forbidden decay. (T.R.H.)

13771 NUCLEAR ORIENTATION OF Pm^{144}. J. F. Schooley, D. A. Shirley, and J. O. Rasmussen (Univ. of California, Berkeley). p.188-91 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Alignment and polarization data were obtained on Pm^{144} in $Nd(C_2H_5SO_5)_3 \cdot 9H_2O$ to verify the Elliott and Stevens theory and furnish information on the magnetic moment of Pm^{144}. Analysis of the γ spectrum gave anisotropies from which the decay scheme of Nd^{144} was confirmed. Nuclear magnetic moments were calculated for $I = 5(1.68 \pm 0.14$ nm) and $I = 6(1.75 \pm 0.14$ nm). (T.R.H.)

13772 NUCLEAR ALIGNMENT OF IODINE BY QUADRUPOLE COUPLING. C. E. Johnson, J. F. Schooley, and D. A. Shirley (Univ. of California, Berkeley). p.191-3 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

An experiment was performed to determine whether pure quadrupole relaxation times in nonmagnetic atoms in crystals become very long at temperatures of the order of 0.01°K. I^{131} was grown in a single crystal of copper iodobenzenesulfonate that was then cooled by adiabatic demagnetization. The γ intensities were measured at several temperatures as a function of the angle between emission direction and the a-axis. The iodine nuclei were aligned. The nuclear spin-lattice relaxation time must be shorter than a few seconds down to 0.03°K. (T.R.H.)

13773 INVESTIGATION OF NUCLEI ORIENTED IN IRON ALLOYS AT VERY LOW TEMPERATURES. A. V. Kogan, V. D. Kulkov, L. P. Nikitin, N. M. Reinov, I. A. Sokolov, and M. F. Stelmach (Inst. of Physics and Tech., Academy of Sciences, Leningrad). p.193-4 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Experiments were carried out on polarization of the oriented nuclei Sc^{46}, Co^{60}, Re^{186}, Ir^{191m}, Ir^{192}, and Au^{199}, using orientation in alloys with iron at very low temperatures. (T.R.H.)

13774 ON ORIENTATION OF NUCLEI IN FERRITES AND GARNETS. G. R. Khutsishvili (Inst. of Physics, Academy of Sciences, Tbilissi, USSR). p.194-6 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Experiments are suggested involving nuclear polarization in ferrite and ferromagnetic garnet. These experiments would have the purpose of obtaining polarized nuclei and also of investigating the properties of ferrites, garnets, and and other nonmetal ferromagnetics. (T.R.H.)

13775 INTERACTION OF POLARIZED RESONANCE NEUTRONS WITH POLARIZED TARGETS. A. Stolovy (U. S. Naval Research Lab., Washington, D. C.). p.196-9 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Experiments to establish spin states by the use of polarized neutrons and a polarized target are described. Results are given for In^{115} and Eu^{151}. (T.R.H.)

13776 SUPERCONDUCTING TRANSITION TEMPERATURES OF TITANIUM AND TITANIUM ISOTOPES. R. G. Netzel and J. R. Dillinger (Univ. of Wisconsin, Madison). p.389-91 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

A study was made of the superconducting transition temperatures of titanium because of a prediction of deviations from the $M^{-1/2}$ dependence of T_c. Isotopically enriched samples were available as was a double capsule calorimeter. The $T_{1/2}$ values obtained (in °K) are: 1.11 ± 0.01 for 99.6% Ti^{50} of mean mass 49.7; 0.22 ± 0.01 for 92.5% Ti^{48} of mean

mass 48.0; 0.36 ± 0.02 for 99.6% Ti^{46} of mean mass 46.3; and 0.266 ± 0.014 for 99.92% iodide crystal bar titanium of natural occurrence. (T.R.H.)

13777 NUCLEAR SUSCEPTIBILITY OF SOLID He^3. Horst Meyer, E. Dwight Adams, and W. M. Fairbank (Duke Univ., Durham, N. C.). p.620-3 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The nuclear susceptibility of solid He^3 was measured at various densities between 0.065 and 1.2°K. Nuclear resonance absorption at frequencies between 3 and 4 Mc was used. The results indicate that for low-density samples, Curie's law is obeyed over the whole temperature range. For high-density samples, a nuclear antiferromagnetic transition seems to occur at temperatures of the order of 0.1°K. The data for liquid helium under pressure, presently being analyzed, do not show any discontinuity in the susceptibility down to the lowest temperatures. (T.R.H.)

13778 SELF-DIFFUSION AND RELAXATION IN SOLID He^3. H. A. Reich (IBM Watson Lab., New York). p.623-4 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The self-diffusion coefficient (D) and the spin relaxation times (T_1 and T_2) were measured in solid He^3 by the spin-echo technique. D, T_1, and T_2 were measured independently as a function of temperature for several constant volumes, both in the α, bcc and the β, hcp phases. The high-temperature end of the T_1 and D curves displays the usual activated diffusion behavior. At the frequency used (5.224 Mc), the curves of T_1 show successive minima, which is characteristic of spin-lattice relaxation caused by diffusion. At the low-temperature end of their curves, T_1 and D become independent of temperature, which is characteristic of quantum tunneling. A sudden decrease of tunneling seems to occur in the β phase. (T.R.H.)

13779 THERMODYNAMIC PROPERTIES OF LIQUID He^3–He^4 MIXTURES. K. W. Taconis (Kamerlingh Onnes Laboratorium, Leiden). p.628-33 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Specific heat measurements with a calorimeter that can be cooled down by means of a He^3 cryostat were made between 0.4 and 2.0°K for the following mole fractions of He^3 in He^4: 0.0466, 0.094, 0.15, 0.291, 0.39, 0.478, 0.575, 0.638, 0.70, 0.75, 0.805, 0.847, 0.894, 0.954, and 1.00. A discontinuity in the specific heat was found at the corresponding λ temperature. In the He I and in the phase separation regions, overheating occurred during the afterdrift, but not in the He II region. The heat of mixing as a function of concentration is given for various temperatures. The excess Gibb's function was calculated. Between 0.4 and 1°K, the heat-capacity measurements of the dilute solutions show an almost constant contribution of very nearly 3/2 RX to the specific heat by the He^3. (T.R.H.)

13780 DISCREPANCIES BETWEEN VARIOUS MEASUREMENTS OF LAMBDA TRANSITION TEMPERATURES OF He^3–He^4 MIXTURES. Thomas R. Roberts and Stephen G. Sydoriak (Los Alamos Scientific Lab., N. Mex.). p.633-7 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Lambda transition temperatures for the entire composition range of saturated liquid He^3–He^4 mixtures were compared. A possible reason for discrepancies, amounting to as much as 0.2°K, is a concentration gradient in measurements involving heat flow or boiling. (auth)

13781 A LATTICE MODEL CALCULATION OF CERTAIN PROPERTIES OF He^3–He^4 MIXTURES. Charles E. Hecht (Univ. of Chicago), Ryoichi Kikuchi, and Paul R. Stein. p.637-40 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Feyman's path integral method was applied for the approximate evaluation of the statistical factor partition function of a liquid mixture of He^3 and He^4 to calculate the variation of the λ point with the mole fraction of He^3. To obtain the curve of isotopic phase separation, it is necessary to estimate at a fixed temperature the dependence of Feynman's dynamical K factor on the mole fraction of He^3. The full formalism of I, II, and III was applied. (T.R.H.)

13782 TEMPERATURE PULSES IN DILUTE LIQUID He^3–He^4 MIXTURES NEAR 0°K. D. J. Sandiford and H. A. Fairbank (Yale Univ., New Haven). p.641-4 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The measurements of effective mass were extended to 20 atm to obtain information on the scattering of phonons by He^3. A cylindrical cavity with carbon resistor board endplates was used, a heat pulse (typically 20 μsec) being transmitted to the helium by one end. The other end receives the temperature disturbance, which is then displayed on an oscilloscope and recorded. The results show that the phonon-He^3 mean free path is long at the lowest temperatures and increases with increase in temperature. Since the first, phonon, pulse is not reflected, it follows that a diffusion process is operative and that the phonon-phonon free path is long, as in pure He^4. The necessary implication of the wave character of the slower pulse, shown by its reflections, is that the He^3–He^4 mean free path is always very short for the conditions encountered. The effective mass of the He^3 excitations at various temperatures and pressures is deduced, and λ is plotted for various temperatures and pressures. (T.R.H.)

13783 PROPAGATION AND ABSORPTION OF SECOND SOUND IN VERY DILUTE He^3–He^4 MIXTURES BELOW 1°K. C. G. Niels-Hakkenberg and H. C. Kramers (Kamerlingh Onnes Laboratorium, Leiden). p.644-7 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

The heat-pulse method was used to study the influence of very small amounts of He^3 on transport phenomena below 1°K in helium II. In the temperature range where second sound is the mechanism for pulse propagation, i.e., not too large a mean free path although the attenuation may already become appreciable, it was argued that the second sound velocity is determined by the velocity of the top of an initially narrow pulse. An estimate of the absorption coefficient of second sound can be made from the width the pulse signal acquires after traveling a certain distance. The analysis of the absorption data is very complicated since diffusion, viscosity, and thermal conductivity may all contribute. It seems reasonable, however, to attribute the main effect to thermal conductivity. Calculated heat-conductivity values are shown and discussed. (T.R.H.)

13784 THE ABSORPTION OF SOUND IN DILUTE SOLUTIONS OF He^3 IN LIQUID He^4. G. O. Harding and J. Wilks (Clarendon Lab., Oxford). p.647-9 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

Earlier results on sound absorption by liquid He II are extended down to 0.4°K using a He^3 cryostat. It is concluded that the second viscosity and the dissipation arising from temperature differences set up by the sound wave are considerably reduced in the presence of the He^3. At the lowest temperatures, the absorption does not decrease with increasing He^3 content as at higher temperatures and appears to become independent of concentration. (T.R.H.)

13785 MEASUREMENT OF THE TOTAL CROSS-SECTION OF SOLID NEON AND ARGON WITH VERY SLOW NEUTRONS. Tasso Springer (Technische Hochschule, Munich) and Werner Wiedemann. p.709-12 of "Proceedings of the VIIth International Conference on Low Temperature Physics." G. M. Graham and A. C. Hollis Hallett, eds. Toronto, University of Toronto Press, 1961.

This paper was previously abstracted from the original language and appears in NSA, Vol. 15, abstract no. 3283.

Particle Accelerators

13786 (BNL-5226) AGS BEAM INTENSITY MEASURING SYSTEMS. H. J. Halama (Brookhaven National Lab., Upton, N. Y.). Jan. 13, 1961. 5p.

A beam-intensity measuring system is described in which bunches of protons are detected by pick-up electrodes, generating a signal that is summed and sent to an amplifier where the fundamental frequency component of the bunches is extracted and amplified. The fundamental frequency components are fed to a peak detector that produces a d-c voltage proportional to the amplitude of the component. The voltage is fed to a digital voltmeter that reads the intensity directly to an accuracy of 0.5%. (B.O.G.)

13787 (BNL-5257) RADIUS JUMP CONTROL SYSTEM. H. J. Halama (Brookhaven National Lab., Upton, N. Y.). Feb. 8, 1961. 4p.

A description is given of the system in which the radial position of the Brookhaven AGS beam is sensed by difference electrodes connected to dual preamplifiers. The system may be used to change the radius of the beam orbit by changing the gain of either electrode or preamplifier. A diagram is given of the components of the system. (B.O.G.)

13788 (BNL-5283) DESCRIPTION OF AGS EXPERIMENTAL BEAMS AS OF FEBRUARY 1, 1961. W. F. Baker, E. D. Courant, and R. H. Phillips (Brookhaven National Lab., Upton, N. Y.). Feb. 1, 1961. 27p.

A description of the channels installed for the beam survey studies at the Brookhaven Alternating-Gradient Synchrotron is given. Maps showing the layout of the shielding and the parts through it are included, along with data on the beam collimators and bending magnets. (J.R.D.)

13789 (CERN-60-39) ABERRATION SPHERIQUE DE QUELQUES LENTILLES ELECTROSTATIQUES A SYMETRIE DE REVOLUTION POUR DES FAISCEAUX DE GRANDE OUVERTURE. (Spherical Aberration of Some Electrostatic Lenses with Symmetry of Revolution for Beams of Large Aperture). Albert Septier (Paris. Université. Laboratoire d'Electronique et Radioélectricité). European Council for Nuclear Research, Geneva. Oct. 13, 1960. 59p.

The purpose of this study was to measure the aberration of the aperture of the different lenses used on the CERN accelerator and then study lenses with low aberrations. The methods of measurement are given for the determination of the principal elements of lenses and of the diameter of the aberration region in a given plane image. The lenses actually employed at CERN are used as an example. Proposals for obtaining a lens with the lowest aberration are given. Two different lenses are envisaged: hyperbolic and dissymmetric; the latter leads to extremely interesting results. (T.R.H.)

13790 (CERN-61-5) DISCUSSION OF A RADIO-FREQUENCY PARTICLE SEPARATOR FOR THE CERN PROTON SYNCHROTRON. W. Schnell (European Organization for Nuclear Research, Geneva). 1961. 44p.

Design parameters and possible performance figures are discussed for a Panofsky r-f particle separator planned for bubble chamber experiments with the CERN synchrotron. The principle of a Panofsky particle separator is two relatively short transverse deflecting r-f cavities separated by a lens system and a drift space. A three-cavity system is also considered and applied to the problem of separating one kind of particle from p, K, and π. (D.L.C.)

13791 (NP-9555) THIRD ANNUAL REPORT FOR THE PERIOD 1st APRIL, 1959 TO 31st MARCH, 1960. (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England). 16p.

Facilities are described and research projects are outlined. Progress is reported on the proton linear accelerator, Nimrod, and bubble chambers. (T.R.H.)

13792 (NYO-6368) INLET SYSTEM FOR B-2. Technical Memorandum No. 23. John Freely (Princeton Univ., N. J. Project Matterhorn). Mar. 22, 1956. 9p.

The requirements are outlined for the gas inlet system for the B-2 stellarator regarding pressure controlling mechanisms. The inlet flow rate was estimated to vary from 7.5×10^{-3} to 7.5×10^{-1} mm liter/sec. The time lag between the setting of a pressure and attaining the pressure in the system is discussed for the cases where the pressure is increased or decreased within the operating range and where the system is brought from the operating range down to the base pressure or the reverse. Tests were conducted to determine the flow rates, effective pumping speed of the test system, pressure, and time constants. (B.O.G.)

13793 (NYO-8063) THE OPTIMIZATION OF STELLARATOR DESIGN UNDER CERTAIN CONDITIONS. Technical Memo. No. 61. M. O. Fuller (Princeton Univ., N. J. Project Matterhorn). July 7, 1958. Includes Appendix by F. Tenney. Contract AT(30-1)-1238. 12p.

The addition of helical windings to the magnetic field coils of a stellarator provides the opportunity for the determination of the proper division of copper between the two windings so as to provide the lowest resistance and hence the highest field strength for a given energy or power input. A derivation is given of an equation for the total resistance, R_T, based on keeping a constant pattern of magnetic configuration. The equation was used to compute values of R_T, from parameters for a proposed B-4 design, for various decimal values of γ, the ratio of outer radius to the inner radius of the field coils S_2/S_1 corresponding to certain values of S_1. Optimum copper distribution and resultant machine parameters are tabulated for coils of 8-in. outside diameter with various vacuum tube sizes. Curves are given for variations of R_T, L/R, and Q with γ. (B.O.G.)

13794 (NYO-8064) TRANSMISSION LINE ENERGY STORAGE SYSTEM. Technical Memo 62. Robert Lugan-

nani (Princeton Univ., N. J. Project Matterhorn). Aug. 13, 1958. Contract AT(30-1)-1238. 20p.

Data are given which illustrate various types of transmission line storage systems. The illustrations include demonstrations of the properties of a uniform line with no mutual coupling, the line supplying power to a class C amplifier, a proposed crowbar arrangement, the effects of various methods of mutual coupling, and the results of a modification of the section nearest the load. (B.O.G.)

13795 (TID-11803) QUARTERLY REPORT TO THE ATOMIC ENERGY COMMISSION FOR THE PERIOD OCTOBER 1, 1960 TO DECEMBER 31, 1960. (Midwestern Universities Research Assn., [Madison, Wis.]). 5p.

The possibility of operating the two-way model accelerator in the one-way mode was examined theoretically and found to be extremely feasible and more stable by a factor of 10 than the two-way mode of operation. Construction progress on the proton accelerator is reported. Theoretical studies of longitudinal instabilities were continued. The design of a bubble chamber is being completed. (M.C.G.)

13796 (TID-11900) DESIGN STUDY OF RADIO FREQUENCY SYSTEMS FOR THE UNIVERSITY OF MICHIGAN 83 INCH CYCLOTRON. Report 200-86-1-R1. William M. Brobeck and F. M. Strange (Brobeck (William M.) and Associates, Oakland, Calif.). Jan. 30, 1961. 111p.

R-f systems covering the range of 6.5 to 15 Mc providing 70 kv peak to ground on two dees were studied. Conceptual mechanical designs and electrical voltage, current, and power calculations are included for several systems. Two systems were considered in detail. These were a quarter-wave vacuum-insulated system and a half-wave system with insulators at the dee tank wall. Either of these systems was considered feasible and neither was considered to have an outstanding advantage over the other. (auth)

13797 (NP-tr-562) A HEAVY-CURRENT MICROTRON. S. P. Kapitza, V. P. Bykov, and V. N. Melekhin. Translated by E. R. Hope from Zhur. Eksptl'. i Teoret. Fiz., 39: 997-1000(1960). 5p. (T-348-R)

Data are presented concerning an efficiency cyclic accelerator of electrons for energies of 5 to 15 Mev. The accelerator is of the electron-cyclotron type. The efficiency of electron capture into resonance orbits and also the general efficiency of the accelerator are appreciably increased by injecting the electrons from a hot cathode located directly in the resonator. The energy and momentum spread of the accelerated electrons is not large. (auth)

13798 SECTOR-FOCUSED CYCLOTRONS. H. G. Blosser (Michigan State Univ., East Lansing). Commun. and Electronics, No. 52, 814-22(Jan. 1961).

The principles of operation of the sector-focused cyclotrons, along with major design problems and the progress made in recent studies of this device, are discussed. The fundamental contradiction between the requirements for focusing and for constant-frequency acceleration in the case of magnetic fields with axial symmetry was solved by Thomas. He proposed a magnetic field which varied with azimuth in such a manner that additional focusing forces were derived from the azimuthal variations. University of California model studies, the phenomena of focusing oscillation resonances, ORNL model studies, and a design proposal for a high-energy sector-focused cyclotron are discussed. The major features of a proposed Michigan State University cyclotron are reviewed. (M.C.G.)

13799 STABILIZATION OF BETATRON GENERATED RADIATION DOSE. G. A. Kabanov (Kirov Tomsk Politechnical Inst., [USSR]). Izvest. Vysshikh Ucheb. Zavedenīĭ, Fiz., No. 2, 81-4(1960). (In Russian)

A device is suggested for stabilizing the radiation dose generated by a betatron. The application of the device in medicine and metallurgy is described. (R.V.J.)

13800 COMPARISONS OF SYMMETRIC AND ORDINARY CASCADE GENERATOR SCHEMES. E. M. Balabanov and Yu. S. Smirnov (Inst. of Physics, the Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 5, 23-7 (Sept.-Oct. 1960). (In Russian)

A symmetric and an ordinary design of cascade generators were investigated. The results are in good agreement with theoretical data. The symmetric design is preferable to the ordinary multiplying design for conditions demanding high stability. (tr-auth)

13801 OMEGATRON WITH HETEROGENEOUS MAGNETIC FIELD. N. I. Leont'ev, Yu. K. Udovichenko, and M. Z. Maksimov. Pribory i Tekh. Ekspt., No. 5, 97-9 (Sept.-Oct. 1960). (In Russian)

Calculations were made of the resolving power and performance of an omegatron with a heterogeneous magnetic field with radial decrease following the parabolic law. For mass-spectrometric analysis, the maximum field decrease should be 3 to 4%. (tr-auth)

13802 A BEAM-CONTROLLING DEVICE AT ACCELERATOR OUTLET. Yu. Ya. Lapitskiĭ and I. N. Slivkov (Inst. of Chemical Physics, the Academy of Sciences, USSR). Pribory i Tekh. Ekspt., No. 5, 121-3(Sept.-Oct. 1960). (In Russian)

A device for transmitting to a control panel data on the shape and position of the beam at the accelerator ion-conducting exit is described. (R.V.J.)

13803 THE CALCULATION OF THE ELECTROMAGNETIC FIELD IN AN ALVAREZ TYPE LINEAR ACCELERATOR. Fred Ford (Manchester Univ., Eng.). Proc. Cambridge Phil. Soc., 56: 252-68(July 1960).

A recently developed theory of the electromagnetic field in nearly periodic structures was used to calculate the field in an Alvarez type linear accelerator. The problem was reduced to the solution of the transmission-line equations for the "voltage" and "current" of the dominant mode. Formulas are given for the coefficients in these equations, and also for the ratio of mode current to accelerating field, as functions of the cavity dimensions of the accelerator; numerical values are given for the Berkeley accelerator. (auth)

13804 PULSED MODULATION OF CYCLOTRON ION BEAM. Sen Ching-hou, Chiang Soon-son, and Gu Yee-fan. Wu Li Hsüeh Pao, 16: 94-7(1960). (In Chinese)

A combination of ion source modulation and modulation of the accelerating voltage was employed in a 1.2-meter cyclotron to obtain a pulsed ion beam. The minimum pulse duration was about 1 to 2 μsec. The frequency could be varied continuously from about 0.2 to 1000 cycles. (auth)

13805 BACKGROUND INFORMATION ON THE HIGH ENERGY PHYSICS PROGRAM AND THE PROPOSED STANFORD LINEAR ELECTRON ACCELERATOR PROJECT. REPORT TO THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES. (United States. Congress. Joint Committee on Atomic Energy). 1961. 449p.

Documents are included which were presented to the Joint Committee on Atomic Energy as background material for study in its consideration of the authorization of the proposed Stanford Linear Accelerator project for fiscal year 1962. They include an over-all report on high-energy (elementary particle) physics, original cost estimates of the six large authorized accelerators and estimates of their total construction and operating costs, engineering

reports on the proposed sites for the Standford accelerator, and a report on the probable scientific man-power requirements of the proposed high-energy physics program. (D.L.C.)

13806 HIGH FREQUENCY POWER TRANSMISSION LINE FOR CYCLOTRONS AND THE LIKE. W. J. Armstrong (to U. S. Atomic Energy Commission). U. S. Patent 2,676,309. Apr. 20, 1954.

High-frequency power transmission systems, particularly a stacked capacitance alternating power current transmission line wherein maximum utilization of the effective conduction skin of the line conductors is achieved while enabling a low impedance to be obtained, are reported. The transmission line consists of a number of flat metal strips with interleaved dielectric strips. The metal dielectric strips are coiled spirally with the axis of the spiral extending along the length of the strips, and the alternating metal strips at the output end have outwardly extending aligned lugs which are directly strapped together and connected to the respective terminals on the load. At the input end of the transmission line, similarly, the alternate metal strips are directly strapped together and connected to an alternating current source. With the arrangement described each metal strip conducts on both sides, so that the metal strips are designed to have a thickness corresponding to twice the depth of the "skin effect" conducting lamina of each conductor at the source frequency.

13807 CLASHING BEAM PARTICLE ACCELERATOR. R. J. Burleigh (to U. S. Atomic Energy Commission). U. S. Patent 2,979,635. Apr. 11, 1961.

A charged-particle accelerator of the proton synchrotron class having means for simultaneously accelerating two separate contra-rotating particle beams within a single annular magnet structure is reported. The magnet provides two concentric circular field regions of opposite magnetic polarity with one field region being of slightly less diameter than the other. The accelerator includes a deflector means straddling the two particle orbits and acting to collide the two particle beams after each has been accelerated to a desired energy. The deflector has the further property of returning particles which do not undergo collision to the regular orbits whereby the particles recirculate with the possibility of colliding upon subsequent passages through the deflector.

Plasma Physics and Thermonuclear Processes

13808 (AFBMD-TR-60-36) PHYSICAL PRINCIPLES OF MAGNETOHYDRODYNAMIC POWER GENERATION. Research Report 69. Richard J. Rosa (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Jan. 1960. Contract AF04(647)-278. 34p.

Some important phenomena in a magnetohydrodynamic power generator are discussed. Particular attention is given to the effects of seeding on gas conductivity and to the Hall effect as it appears in nonuniform gases of finite extent. An experimental 10-kw magnetohydrodynamic generator is described. An arc wind tunnel or "plasma jet" is used as a convenient laboratory "furnace" to heat the working fluid. The generator's performance, including some observed Hall effects, is presented and discussed. (auth)

13809 (AFOSR-174) CUSP PHENOMENA IN THE REGION OF TWO NEIGHBORING THRESHOLDS. Technical Report No. 205. J. Sucher, G. A. Snow, and T. B. Day (Maryland. Univ., College Park). Jan. 12, 1960. 16p.

Previous discussions of the cusp phenomena at the threshold for a new reaction are extended to the case of two neighboring thresholds. The S matrix is constructed from an n x n K matrix in such a way as to ensure that the physical S matrix is unitary when only r of the n channels are open. As a special application the amplitude for the reaction $\pi^- + p \rightarrow \Lambda^0 + K^0$ is studied in the region of the Σ^- and Σ^0 thresholds. (auth)

13810 (ARF-1121-4) RESEARCH IN THE MEASUREMENTS AND THEORY OF PLASMOIDS AND THEIR APPLICATIONS TO MISSILES AND SATELLITE TECHNOLOGY. First Annual Report, Period Covered June 1, 1958–May 31, 1959. Dale J. DeGeeter (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 11, 1959. Contract AF33(616)-5791. 59p.

Finite plasmas, termed plasmoids, were produced and studied. A convenient and flexible experimental apparatus was designed and constructed for producing the phenomena. An image converter light shutter unit is near completion which will allow examination of the plasmoid shape. Microwave equipment is being added to the system for measurements on the electron density and internal magnetic fields in the plasmoids. Time-exposure photographs were made under various conditions of magnetic field and background gas pressure and show strong dependence of plasmoid characteristics on these parameters. Concurrent theoretical investigations of the stability of cylindrical plasma configurations were made, complementing the experimental phase. The simplest configuration whereby the internal magnetic field of the cylinder is "force-free" was found incompatible due to the inability to meet boundary conditions. A more complex situation is now being treated where the stability or instability is controlled by interactions between the magnetic fields and fluid motions within the plasmoid. (auth)

13811 (ARF-1121-8) RESEARCH IN THE MEASUREMENTS AND THEORY OF PLASMOIDS AND THEIR APPLICATIONS TO MISSILES AND SATELLITE TECHNOLOGY. Second Annual Report, Period Covered June 1, 1959–May 31, 1960. Dale J. DeGeeter (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 14, 1960. Contract AF33(616)5791. 50p.

Finite high-velocity plasmas, termed plasmoids, are being investigated experimental and analytically. Optical measurements, including the development of an image converter camera, are reported. The results of the microwave interaction experiment are summarized. Analytically, the plasmoid stability problem was analyzed for possible presentation to the Univac 1105 computer. Simultaneously, a solution to the Boltzmann's equation for electrons in a slightly ionized gas under the influence of an electric field, magnetic field, and density gradient was completed. The work was also extended to include the case of a highly ionized gas, taking into account the scattering by ions and electrons. (auth)

13812 (ARF-1121-9) RESEARCH IN THE MEASUREMENTS AND THEORY OF PLASMOIDS AND THEIR APPLICATIONS TO MISSILES AND SATELLITES TECHNOLOGY. Quarterly Report, Period Covered June 1, 1960–August 31, 1960. Lawrence C. Scholz and Dale J. DeGeeter (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Sept. 1960. Contract AF33(616)-5791. 29p.

Investigations into the measurement and theory of plasmoids and their application to missile and space technology are reported. Structure and formation mechanisms

are considered. Modification of the experimental apparatus, plasmoid source, high-voltage switching, image converter camera, and future work is discussed. An experimental analysis of two identical plasmoids propagating to each other is presented. (W.D.M.)

13813 (ARL-TR-60-171) ON THE DETERMINATION OF MEAN EFFECTIVE TEMPERATURES IN PLASMAS USING SHOCK WAVE MEASUREMENTS. H. J. Kaeppeler, B. Mayser, and W. Zimmermann (Stuttgart. Technische Hochschule. Institut für Hochtemperaturforschung). Aug. 1960. 33p. (AD-248319).

A method for determining mean effective temperatures in short-time electric discharges in a cylindrical plasma column is described which is based on the operation of a shock tube. The theory of this method is presented, and the procedure for measurements is discussed. Reacting and nonreacting driver gases are considered, with the driven gas in the tube proper assumed to be nonreacting. Tables are included for evaluating measurements with nonreacting gases. A Mollier chart is also included for reacting nitrogen as a driver gas. (auth)

13814 (AWRE-0-70/60) CONDITIONS AT EQUILIBRIUM BEHIND STRONG SHOCK WAVES IN HYDROGEN. G. B. F. Niblett (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Feb. 1961. 21p.

The equilibrium conditions behind strong shock waves traveling into hydrogen gas at ambient temperatures and at pressures of 1 to 10,000 μ of mercury were determined from the conservation equations and the ionization equation. The results are presented graphically. The curves apply to deuterium gas if the abscissas are adjusted by the factor $\sqrt{2}$. (auth)

13815 (CEA-1703) MEASURE DE LA DENSITE ELECTRONIQUE DES MILIEUX IONISES PAR DES METHODES HYPERFREQUENCES. (Measurement of the Electronic Density of Ionized Media by Hyperfrequency Methods). T. Consoli (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). Sept. 27, 1960. 121p.

Within the limits of the INSTN courses on plasmas, this analytical study summarizes the articles quoted in the references on hyperfrequency techniques for the measurement of electronic density of an ionized gas. It is neither exhaustive nor complete, and further details may be obtained by referring to the works mentioned. The first part, devoted to the theoretical side, concerns the propagation of electromagnetic waves in ionized media and the excitation of stationary waves in electromagnetic cavities. The second part deals with the measurement techniques themselves. It includes those techniques that have become classics and more recent ones being developed in various laboratories and in the Service of Applied Physics at Saclay. (auth)

13816 (CF-61-2-57) APPARENT OBSERVATIONS OF IONIC SOUND WAVES IN AN ARC PLASMA. I. Alexeff and R. V. Neidigh (Oak Ridge National Lab., Tenn.). Feb. 13, 1961. 28p.

Oscillations were observed in a magnetically supported cylindrical rod of plasma. These oscillations appeared to be produced by a longitudinal standing ionic sound wave in the plasma column. General properties of ionic sound waves are described. A model for a resonant system based on ionic sound waves and predictions of the model are discussed. Experimental results that appeared to support this model include oscillations found in the defining aperture of a Mode-II pressure-gradient arc, oscillations in the core of a Mode-I arc, and pulsations and cyclotron resonances. The theory of sound waves applied to radiofrequency plasma noise is discussed. (M.C.G.)

13817 (GA-1550) COHERENT EXCITATION OF PLASMA OSCILLATIONS IN SOLIDS. David Pines (General Atomic Div., General Dynamics Corp., San Diego, Calif. and Texas Atomic Energy Research Foundation, Dallas). July 29, 1960. 10p.

A summary is presented of investigations related to the collective behavior in solid state plasmas. Particular attention is directed to the feasibility of observing in such plasmas, a high frequency instability associated with the coherent excitation of plasma oscillations. The instability arises if a sufficiently large drift of electrons vs. holes in semiconductors is produced under the action of an applied electric field. (J.R.D.)

13818 (MATT-53) STABILITY OF NON-LINEAR TRAVELING WAVES IN A COLD PLASMA. E. Atlee Jackson (Princeton Univ., N. J. Project Matterhorn.). October 1960. 8p. Contract AT(30-1)-1238.

Although it has been known for some time that there can be nonlinear, electrostatic, traveling waves in a plasma, none of these wave forms have been shown to be stable. The one exception is when the ions are infinitely massive and the electron velocity distribution is $f_e = n(x,t)\ \delta\ (v - u(x,t))$. In this case Dawson's work leads to the conclusion that the waves are stable, for he showed that in the frame in which the ions are at rest all "noncrossing" motions are periodic with a period $2\pi/\omega_p$. The stability of these waves (for spatially bounded perturbations) using the usual Eulerian equations are established. In the course of proving stability, the equations can be integrated, yielding the eigenfuctions that go as $e^{i\omega t}$ in the wave frame. The value of ω is unrestricted, and the eigenfunctions are not simply periodic in space unless ω/ω_p is rational. (auth)

13819 (MATT-60) ECONOMIC PROSPECTS FOR THERMONUCLEAR REACTORS. R. G. Mills (Princeton Univ., N. J. Plasma Physics Lab.). Feb. 3, 1961. Contract AT(30-1)-1238. 41p.

The economics of a hypothetical thermonuclear reactor based on the stellarator concept was investigated. Scaling laws of thermonuclear power are discussed. Four examples of thermonuclear reactors are described and cost estimates given. It was concluded that when successful confining and heating in stellarators is demonstrated, then economically attractive controlled thermonuclear reactors will be possible. (M.C.G.)

13820 (NP-9792) ON THE DETECTION OF ION OSCILLATIONS IN A MERCURY DISCHARGE. Burton D. Fried and Roy W. Gould (Space Technology Labs., Inc. Physical Research Lab., Los Angeles). Dec. 9, 1960. 15p. (STL-TR-60-0000-GR413).

The possibility of using a low-pressure mercury discharge to detect ion-plasma oscillations is examined. It is found that collisions will not interfere with the phenomenon and that the current that maintains the discharge will cause the waves to grow (through the two-stream instability) in a time comparable with or less than the oscillation period. Aside from complications caused by the fact that the maximum growth occurs at rather short wavelengths ($\lambda \lesssim 0.5$ mm), detection of these waves appears quite feasible. (auth)

13821 (NP-9875) IMPURITY RADIANT ENERGY LOSS. S. M. Berman (Space Technology Labs., Inc. Physical Research Lab., Los Angeles). Nov. 22, 1960. 20p. (STL/TR-60-0000-GR435)

A study is made of the level population of the energy loss due to radiation of impurity atoms or ions in an ionized me-

dium. A simplified model similar to that of Post is examined in which the impurity is assumed to have only two states and to interact with a Maxwellian background of electrons. Equations are derived for departures of the energy levels from Boltzmann equilibrium. The case where radiation transfer is made via the impurity only is treated. Equations of radiation transfer are solved for a two-dimensional plane plasma. The approximation of O VI and O VIII impurities in plasmas and the radiation of a hydrogen plasma are considered. An equation is derived for the relation between collision frequencies ν_1 and ν_2 for a two-state system undergoing encounters with electrons of a definite distribution function. (D.L.C.)

13822 (NYO-2410) EFFECT OF AN INFINITELY PERMEABLE TORUS ON AN INITIALLY UNIFORM MAGNETIC FIELD. Technical Memorandum No. 6. William A. Newcomb (Princeton Univ., N. J. Project Matterhorn). Jan. 23, 1953. 7p.

The situation of a ferromagnetic torus surrounding a tube along whose axis a uniform magnetic field runs is considered. The magnetic-field reduction due to torus polarization is calculated, assuming an infinite torus permeability. The total field (sum of field and induced field) is plotted vs. r/c, where r is the distance of the field from the tube and c is the mean radius of the torus. It is found that the torus reduces the magnetic flux through the tube by ~8.5%. (D.L.C.)

13823 (NYO-6365) STRESS ANALYSIS OF COIL SUPPORT FRAMES FOR B-3 MACHINE. Technical Memorandum No. 20. John K. Earon (Princeton Univ., N. J. Project Matterhorn). Dec. 29, 1955. 19p.

An analysis was conducted to determine the magnitude of stresses in a coil support frame that was subjected to 20,000-pound axial-force fault conditions and to determine the deflections produced under normal and fault-condition loading. None of the stresses or deflections was considered dangerous or excessive, and the frame appears to have sufficient strength to withstand such fault conditions. (J.R.D.)

13824 (NYO-8067) MAGNETIC FIELD LINES IN A STELLARATOR. Technical Memo 65. John M. Greene, John L. Johnson, and Richard W. Palladino (Princeton Univ., N. J. Project Matterhorn). Oct. 14, 1958. 7p.

A model was constructed which shows the magnetic-field lines in a portion of a straight section of a stellarator in which current in helical or corkscrew windings provides the rotation of the lines of force. The model is described, and calculations are included for one case. (J.R.D.)

13825 (NYO-9370) THEORY OF CUSPED GEOMETRIES. IV. PARTICLE LOSSES IN CROSSED FIELDS. John Killeen (New York Univ., New York. Inst. of Mathematical Sciences). Nov. 15, 1960. Contract AT(30-1)-1480. 42p. (MF-8)

The loss of particles through a cusp of a particular containment geometry utilizing cusped magnetic-field lines is considered. A velocity space loss criterion analogous to the loss cone in the mirror machine is derived. The effect of a uniform longitudinal magnetic field perpendicular to the containing field is considered, and a loss criterion is derived. The effect of the longitudinal field is to decrease cusp losses. (auth)

13826 (NYO-9489) ON THE GREEN'S FUNCTION FOR TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC WAVES. [PART] II. Harold Weitzner (New York Univ., New York. Inst. of Mathematical Sciences). Dec. 15, 1960. Contract AT(30-1)-1480. 20p. (MF-11)

As an extension of an earlier report, Green's function was evaluated for the Lundquist equations linearized about a uniform magnetic field, constant matter density, and zero flow velocity. It was assumed that all quantities are functions only of two space variables and time. In the general magnetic-field configuration considered, a pure Alfven disturbance does not exist; instead a wave with properties of both the Alfven and fast-slow disturbance was present. (auth)

13827 (PIBAL-627) EXCITATION OF PLASMA WAVES BY BODIES MOVING IN IONIZED ATMOSPHERE. K. P. Chopra (Brooklyn. Polytechnic Inst.). Jan. 1961. Contract AF49(638)-445. 17p. (AFOSR-1)

A body moving in an ionized atmosphere acquires an electric charge through the processes of accretion of charged particles and emission of electrons by high-energy photons. The moving charged body may then interact with the charged particles of the atmosphere and any pervading magnetic field to excite plasma waves. Of particular interest is the situation in which the body collects an ionized cloud in front of it. The motion of this cloud in the atmosphere induces an electrostatic instability and causes a column of ionized gas to move ahead of the body. The electrostatic instability is conducive to the excitation of electrostatic oscillations, which, if already present, are further enhanced. A magnetic field along the direction of motion assists in the formation of the ionized cloud. If the pervading magnetic field is of a suitable strength, it may excite extraordinary electromagnetic waves. A pervading transverse magnetic field of suitable strength may cause the excitation of magnetohydrodynamic waves. (auth)

13828 (PPL-60-15) A REVIEW OF REPUBLIC'S PINCH ENGINE EXPERIMENTAL PROGRAM. Irving Granet and William J. Guman (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). Oct. 21, 1960. 40p. Contracts Nonr-2851(00) and AF49(638)-552. (AFOSR-164)

The experimental program of Republic Aviation in plasma physics is described in detail. The test units used in the program include Test Rigs No. 1 and 2, the Triggered Gap Switch, and the Fast Acting Gas Valve. Some of the instrumentation developed in conjunction with the program is described: rotating drum camera, rotating mirror camera, light probes, magnetic probes, thrust-measuring devices, surface thermocouples, the Schlieren shadowograph, and a velocity spectrometer. The measurement of the plasma velocity is discussed, and experimental results are presented for Test Rig No. 2 with various electrode nozzle contours. Measurement of the mass injected into the nozzle per pinch is also considered, and data are presented for Test Rig No. 2 which shows the effects of pulse rate and propellant pressure. Thrust and pinch initiation are treated. (D.L.C.)

13829 (PPL-TR-60-9) AN ANALYTICAL APPROACH TO THE PROBLEM OF PINCH DYNAMICS. Boa-Teh Chu (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). Nov. 1960. Contract AF49(638)-552. 31p. (AFOSR-TN-19)

The motion of a gas between two parallel circular electrodes during the pinch process is analyzed from the fluid dynamical viewpoint. The solution is presented in the form of a double-series expansion, the first term of which agrees with that deduced from the snow-plow model. The higher order terms in the expansion give a detailed description of the motion of the gas between the advancing shock and the current sheath. (auth)

13830 (TID-11029) AN INVESTIGATION OF THE EQUILIBRIUM PROPERTIES OF A FULLY IONIZED GAS.

Final Report, August 1, 1958 to October 31, 1960. W. E. Brittin (P.E.C. Corp., Boulder, Colo.). Contract AT(11-1)-669. 150p.

A discussion is given of the formalism of second quantization in which two spaces are considered: the configuration space of ordinary quantum theory and an abstract space which is isomorphic to the space of second quantization. A connected diagram expansion derivation is given for a gas having particles of only one type. Diagrams are discussed for spinor operators and a transition to momentum space. The diagram technique is shown to lead to the exact partition function for the special case of noninteracting particles in an external field. A derivation is given of the equation of state for a hydrogen plasma. The boundary conditions and effective potentials near electrons and ions, as well as the average potential per unit volume, are given. The calculated results are presented graphically. (B.O.G.)

13831 (TID-11565) NON-RELATIVISTIC CONTINUUM DYNAMICS. F. W. Mezger (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Nov. 1, 1960. Contracts AF33(600)-38062 and AT(11-1)-171. 25p. (XDC-60-12-47).

Lecture notes are given which were used in a plasma physics course. The subject of continuum dynamics is introduced in a unified fashion as a basis for an understanding of equations of magnetohydrodynamics. (auth)

13832 (UCRL-9482) EXPERIMENTS ON ALFVEN-WAVE PROPAGATION. John M. Wilcox, Alan W. DeSilva, William S. Cooper, III, and Forrest I. Boley (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1960. Contract W-7405-eng-48. 31p.

Experimental results were obtained for comparison with a theoretical description of a hydromagnetic waveguide. The hydromagnetic waveguide used was a cylindrical copper tube 15 cm in diameter and 86-cm long. It was filled with hydrogen to a pressure of 100 μ and immersed in a magnetic field of 15 kgauss. The plasma was produced by a switch-on shock wave that produced almost 100% ionization. Ion densities were measured with an accuracy of about ±15% by observing with a monochromator the profiles of the first three Balmer lines and comparing with a careful theory of Stark broadening developed by Griem, Kolb, and Shen. The ion density decreased by a factor of 3 in 300 μsec because of recombination and diffusion losses. A hydromagnetic wave was induced by discharging a capacitor between the copper cylinder and a small coaxial electrode mounted in a pyrex insulator at one end of the tube, thus inducing the wave that Newcomb has labeled a principal mode. The integrated-wave electric field was observed between coaxial electrodes, and the wave magnetic field and radial-current density were observed with probes. The Alfvén velocity is $V_A = B/(\mu_0 \rho)^{1/2}$. Inserting the spectroscopic measurement of ion density and the known value of axial magnetic field into this expression yielded a wave velocity in agreement with experiment. The wave velocity was observed to vary linearly with magnetic field, and the attenuation agreed roughly with theoretical predictions. The azimuthal magnetic field, b_θ, associated with the wave was measured to be about 1% of the static axial field of 15 kgauss. The radial distribution of b_θ was described by a first-order Bessel function as predicted by theory. Wave reflections were observed from a high-impedance boundary (a pyrex plate at the end of the cylinder), a low-impedance boundary (a copper plate), and a plasma-neutral gas interface. In all cases the change in phase of the electric and magnetic fields of the reflected wave agreed with theory. (auth)

13833 (UCRL-9503) THE E × B DISCHARGES AS A SOURCE OF IONS. Kenneth W. Ehlers (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 10, 1961. Contract W-7405-eng-48. 26p.

The use of an E × B type of discharge as a source of ions was investigated. For standard applications, this use appears limited because the ions obtain energy while still within the arc structure. If the proper polarities are used, the ions exhibit the interesting characteristic of self-extraction. The E × B geometry operates as an effective ion pump for light gases. Discharge conditions and ion output characteristics are discussed. (auth)

13834 (WADC-TR-59-321) PULSED PLASMA PROPULSION — AN ADVANCED REACTION SPACE PROPULSION SYSTEM. Final Report. (Borg-Warner Corp. Research Center, Des Plaines, Ill.). June 1959. Decl. Sept. 30, 1959. Contract AF33(616)-6036. 61p.

A study comprising an analytical investigation, an experimental investigation, and a missions analysis is summarized. The analytical investigation includes results of an analog-computer study of acceleration of plasma by parallel rails. The experimental investigation consists, primarily, of single-pulse studies of the parallel-rail plasma accelerators. No auxiliary accelerating fields are used. A missions analysis for use of the pulsed plasma acceleration for a one-year sustainer for a satellite in an 80-mile orbit is included. (auth)

13835 (JPRS-7787) THE PISTON PROBLEM IN MAGNETOHYDRODYNAMICS. A. A. Barmin and V. V. Gogosov. Translated from Doklady Akad. Nauk S.S.S.R., 134: 1041-3 (Oct. 1960). 9p.

The problem of the motion of a piston in a conducting medium in the presence of a magnetic field is studied, assuming that both the piston and the medium are ideal conductors. A diagram shows the different combinations of shock waves, refraction waves, and Alfven explosions which can precede the piston. The different combinations are shown to depend on the piston velocity. (D.L.C.)

13836 THE GENERAL THEORY OF THE MOTIONS OF IONS AND ELECTRONS IN GASES. L. G. H. Huxley (Commonwealth Scientific and Industrial Research Organization, Melbourne). Australian J. Phys., 13: 718-37(Dec. 1960).

General formulas for the drift velocities and diffusion coefficients of ions and electrons in gases are derived by the application of dynamical principles. These formulas agree with those established by proper application of the method of free paths. Formulas for the distribution of speeds of agitation are also derived. (auth)

13837 SOME BASIC CONCEPTS FOR MAGNET COIL DESIGN. W. F. Gauster (Oak Ridge National Lab., Tenn.). Commun. and Electronics, No. 52, 822-8(Jan. 1961).

Theorems that are of special interest in the design of large d-c magnet coils as used in the DCX thermonuclear research program are discussed. The design of the high-power magnet coils is based on fundamental work by Fabry, Cockcroft, and Bitter. A general law for the optimum current density distribution of a coil of known shape and a general expression for the Fabry factor were derived. Examples of larger coils with optimum current density distribution are given. The optimum shape of a coil where the current density distribution is known was also determined. (M.C.G.)

13838 FUSION POWER FROM MAGNETICALLY CONFINED PLASMA. R. G. Mills (Princeton Univ., N. J.). Commun. and Electronics, No. 52, 833-6(Jan. 1961).

On the basis of an assumed magnetically confined, stable, quiescent plasma, the relations for the fusion power liber-

ated and the electric power consumed to generate an externally applied magnetic field were considered. From these, appropriate scaling laws were developed which show the relative importance of various machine parameters, independently of the specific form of machine assumed. In the event that any of this class of machines should be proved physically possible, the directions of development needed to improve the economy of a resulting power-generating system are indicated. The advantages and disadvantages of various methods of increasing the yield of a fusion plant are compared. (auth)

13839 HEAT TRANSFER OF COMPLETELY IONIZED PLASMA. Yu. A. Pekar (Tula Inst. of Mining, [USSR]). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 99-102 (1960). (In Russian)

Temperature distributions of electrons and ions in completely ionized plasma, limited by parallel conducting walls, were found for two nonisothermal conditions with constant current densities along the cross section. (tr-auth)

13840 EXPERIMENTAL DETERMINATION OF MAGNETIC SUSCEPTIBILITY OF PLASMA. V. G. Stepanov and D. A. Pulin (Kirov Ural Polytechnic Inst., [USSR]). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 2, 239-40 (1960). (In Russian)

The magnetic susceptibility of plasma, measured at various constant magnetic fields, was 3×10^{-4} cm^3; consequently the plasma exhibits macroscopic diamagnetic properties. In the examined case the mean magnitude of a counter field inside the plasma reached the order of 1 gauss. (R.V.J.)

13841 THE INFLUENCE OF AN EXTERNAL MAGNETIC FIELD ON STATIONARY LAYERS IN AN ELECTRIC DISCHARGE PLASMA. F. C. Kochanov and O. V. Prudkovskaya (Moscow Inst. of Light Industry and Kuibyshev Aviation Inst., [USSR]). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 5, 153-61(1960). (In Russian)

The influence of a magnetic field on the laminated, positive pinch discharges in hydrogen and neon was analyzed. The theory of striation diffusion correlated with experimental data indicates agreement. A solution was found for the ambipolar diffusion expression for two strongly contrasting ionization coefficients in the glow and dark regions of the pinch. (tr-auth)

13842 EXCITATION OF OSCILLATIONS IN ELECTRON-OSCILLATING SPECTRUM OF HIGH-FREQUENCY DISCHARGE IN NITROGEN. T. N. Popova and N. A. Bokova (Siberian Inst. of Physics and Tech., Tomsk State Univ.). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., No. 5, 174-5(1960). (In Russian)

Previous work indicated that the molecular distributions in glow discharge comply with the exponential law $n_i = n_0 e^{-(\varepsilon_i/kT_{eff})}$, where T_{eff} is the temperature describing the distribution, differing from both the electron and gas temperatures. An attempt was made to investigate the saturation of the $C^3\Pi$ and $B^3\Pi$ oscillation levels of N_2 molecules in high-frequency discharge. Lines with $\Delta u = -1, -2$, and -3 in the second positive system and lines $3 \rightarrow 0$, $4 \rightarrow 1$, $5 \rightarrow 2$, $6 \rightarrow 3$, and $7 \rightarrow 4$ in the first positive system were selected for the investigation. (R.V.J.)

13843 RECOMBINATION THROUGH ELECTRON-ELECTRON COLLISIONS. D. R. Bates and A. E. Kingston (Queen's Univ., Belfast). Nature, 189: 652-3(Feb. 25, 1961).

In dense plasmas, recombination through electron-electron collisions can be the major cause of loss of free electrons. The mechanism is akin to three-body ionic recombination but differs because of the long-range Coulomb forces involved because the bound states cannot be treated as forming a continuum and because of the effect of radiative transitions. Suppose that the ions are protons and suppose also that the temperature is such that the mean thermal energy is much less than the first excitation energy of hydrogen. Radiative recombination is slow, but highly excited hydrogen atoms are rapidly formed through electron-electron collisions: $H^+ + e + e \rightarrow H' + e$. These atoms may be ionized by the reverse process; or they may gain or lose internal energy by suffering superelastic or inelastic collisions with electrons or by absorbing or emitting photons. The passage of an electron from a state of the continuum to the ground state of an atom is clearly in the nature of a random walk during the course of which many different states may be entered. Calculations have been carried out to cover various conditions. Some representative results are presented. (auth)

13844 CLUSTER INTEGRAL THEORY OF DISTRIBUTION FUNCTIONS OF SPATIALLY NONUNIFORM SYSTEMS. Russell V. Hanks (Boeing Scientific Research Labs., Seattle). Phys. Fluids, 4: 292-9(Mar. 1961).

The theory of the pair distribution function of quantum and classical systems developed by Fujita, Isihara, and Montroll was extended to apply to spatially nonuniform systems. Cluster integral expansions of the singlet and pair distribution functions were developed for both one- and two-component systems and were used to derive general expressions for these functions of noninteracting Fermi-Dirac and Bose-Einstein gases. The pair distribution function of a low-density high-temperature plasma in a homogeneous external magnetic field was also considered, and it is shown, under certain assumptions, that the Debye screening length is unaffected by the field. (auth)

13845 STATISTICAL DISTRIBUTION OF THE MAGNETIC MICROFIELD IN A PLASMA. G. Kalman (Israel Inst. of Tech., Haifa). Phys. Fluids, 4: 300-1(Mar. 1961).

The static magnetic field due to randomly distributed charged particles in phase space was investigated. A Holtsmark-like distribution was derived, centered around 2.0091 B_0, the latter being the magnetic field caused by a particle moving with the average velocity at an average interparticle distance. (auth)

13846 HYDROMAGNETIC EQUILIBRIA IN A TOROID FROM THE PARTICLE POINT OF VIEW. Russell M. Kulsrud (Princeton Univ., N. J.). Phys. Fluids, 4: 302-14 (Mar. 1961).

Hydromagnetic equilibria were considered as being time-independent solutions of the Boltzmann equations and Maxwell's equations. The short-range collisions were neglected, and the magnetic field was taken large enough to make the small gyration radius low-frequency expansion of the equations by Chew, Goldberger, and Low (unpublished work) applicable. The equilibria are discussed only to lowest order in this scheme and in geometries topologically equivalent to a torus. In particular, magnetic surfaces are shown to exist. A set of invariants for slow motions of the system was determined. These invariants were used as constraints in a variational principle which states that subject to these constraints an arbitrary configuration makes the energy stationary if, and only if, it is an equilibrium state. The case of equilibria with trapped particles was treated separately. It is proposed that the values of these invariants serve to characterize toroidal hydromagnetic equilibria. (auth)

13847 HYDROMAGNETIC STABILITY OF A TUBULAR PINCH. William A. Newcomb and Allan N. Kaufman (Univ.

of California, Livermore). Phys. Fluids, 4: 314-34(Mar. 1961). (AERE-5434)

Necessary and sufficient conditions were derived for the hydromagnetic stability of a tubular pinch with a very thin current layer. The derivation was based on the energy principle, according to which a system is stable if, and only if, the energy integral is positive for every virtual displacement. The virtual displacements were divided into two types, depending on whether their radial components were continuous or discontinuous in the limit of an infinitely thin layer. Separate stability criteria are given for each type, and stability diagrams are constructed on the basis of numerical calculations. The tubular-pinch results are supplemented with a brief discussion of the columnar pinch, and it is concluded that the tubular pinch is easier to stabilize. (auth)

13848 STATIONARY NONLINEAR PLASMA OSCILLATIONS. Hans Wilhelmsson (Princeton Univ., N. J.). Phys. Fluids, 4: 335-40(Mar. 1961). (MaH-52)

The frequency of nonlinear free oscillations was investigated in the following one-dimensional situations: cold plasma including ion motion; plasma with a spread in the velocity distribution; and the two-stream case. In each case a dependence of the frequency on the degree of nonlinearity was obtained. (auth)

13849 GENERATION OF THE THIRD HARMONIC BY AN ELECTROMAGNETIC SIGNAL IN A PLASMA. Philip Rosen (Yale Univ., New Haven). Phys. Fluids, 4: 341-5 (Mar. 1961).

The amplitude of the third-harmonic current density was calculated by using the method of Margenau and Hartman. The equations led to a tenable solution, provided the field strength was small. An inequality is given for the region where the solution is valid. (auth)

13850 LAGRANGEAN DENSITY FOR AN INVISCID, PERFECT, COMPRESSIBLE PLASMA. Sylvan Katz (Aeronutronic, Newport Beach, Calif.). Phys. Fluids, 4: 345-8(Mar. 1961).

A Lagrangian density formulated in the Lagrangian coordinate system is proposed for a one-fluid, inviscid, perfect, compressible plasma undergoing isentropic motion in an electromagnetic field. Variations of the electromagnetic field potentials yield Maxwell's equations, whereas variations in the particle paths result in the equations of fluid motion. (auth)

13851 PARAMETRIC STUDY OF THE CONICAL SHOCK TUBE. Vernal Josephson and Richard W. Hales (Space Technology Labs., Los Angeles). Phys. Fluids, 4: 373-9(Mar. 1961).

A parametric study was made on the performance of a conical discharge shock generator. From these studies it was possible to formulate general ground rules to be followed in designing a shock tube of this type capable of producing a single high-velocity shock at gas pressures varying from 25 to 2000 μ. Typically, shocks of $M_s \approx 150$ were produced in D_2 at 100 μ pressure. (auth)

13852 MAGNETOHYDRODYNAMIC FLOW THROUGH DUCTS OF VARIABLE CROSS SECTION. Jan Rosciszewski (Technical Univ., Warsaw). Phys. Fluids, 4: 386-8(Mar. 1961).

Equations governing the quasi-one-dimensional nonsteady flow of fluid of infinite electric conductivity through ducts of variable cross section are presented. The equations were obtained by assuming that only one component of the magnetic field is not equal to zero. The problem of propagation of a shock wave through a duct of variable cross section and the interaction of shock and simple waves could be solved with these equations. (M.C.G.)

13853 APPLICATION OF BOHM'S CRITERION FOR THE FORMATION OF A SHEATH. Laurence S. Hall (Univ. of California, Berkeley and Livermore). Phys. Fluids, 4: 388-9(Mar. 1961). (AERL-9401). (UCRL-9401)

It is shown that the use of Bohm's criterion for the formation of a wall sheath by Hoh in an attempt to explain the marked change in behavior of the positive column of a glow discharge in a magnetic field as the magnetic induction is increased beyond a critical value is not justified. A review of the Bohm derivation of the potential distribution within a sheath is presented. It was concluded that the nonsatisfaction of Bohm's criterion should be considered more as a warning against a breakdown of the theoretical model than as a condition in the system itself. (M.C.G.)

13854 COMMENTS ON SCHMIDT'S VIRIAL THEOREM FOR PLASMAS. R. B. R. Shersby-Harvie (Services Electronics Research Lab., Baldock, Herts, Eng.). Phys. Fluids, 4: 389-90(Mar. 1961).

Schmidt's theorem which shows that a plasmoid cannot be self-containing in a stationary state does not exclude the possibility of a slowly decaying plasmoid. In this case, two additional terms were found to be necessary: volume and surface integrals of the electromagnetic terms. An approximation neglecting collisions was used to evaluate these terms. The particular case of containment by transverse r-f electric fields was considered. (M.C.G.)

13855 ON THE KINETIC EQUATION FOR A HIGH TEMPERATURE PLASMA. Yoshi H. Ichikawa (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 24: 1083-1108(Nov. 1960). (In English)

Effects of binary and ternary correlations in a high-temperature plasma are examined in detail on the basis of the so-called B-B-G-K-Y equation for a system of charged particles. It is shown that the effects of ternary correlation are essential in giving rise to shielding of the interaction between particles, and that these effects have important influences upon disturbances of the binary correlations. The effects of binary correlation can be divided into the correction terms of the self-consistent field of the Boltzmann-Vlasov equation and the terms representing the collision effects between particles through the shielded interaction. The effects of the collision terms are investigated in detail by deriving a generalized Fokker-Planck equation. The effects of the correction terms of the self-consistent field are examined by deriving an equation of motion of the density fluctuation which describes the longitudinal plasma oscillations. The correction terms give rise to a shift of the k^2-term of the plasma frequency and a damping factor. The frequency of the plasma oscillations is given by $\omega^2 = \omega_p^2 + (1 + \delta)(3kT/m)k^2$ where the shift due to the binary correlations δ is $\delta = 1.05\{(e^2/\kappa T)^3 n\}^{1/3}$, and the damping factor γ is $\gamma = 0.028\{(e^2/\kappa T)^3 n\}^{1/2} (k/k_d)^2 \cdot \omega_p$ at the limit of $k \to 0$. It is shown that the damping factor due to the long-range binary correlations predominates over the Landau damping in the range of small value of k. On the basis of present investigation, it is concluded that the equation derived by Balescu does not involve any information concerning the plasma oscillations. Since the plasma oscillations are nothing but the appearance of periodical spatial inhomogeneity in the system, it is evident that the assumption of spatial homogeneity introduced by Temko, Tchen and Balescu in their derivations of the fundamental equations rules out the possible occurrence of the plasma oscillation. (auth)

13856 PLASMA INVESTIGATIONS WITH THE "ALPHA" FACILITY. V. V. Afrosimov, V. A. Glukhich, V. E. Golant, A. N. Zaĭdel', E. G. Komar, B. P. Konstantinov, G. M. Malyshev, I. F. Malyshev, N. A. Monoszon, A. M. Stolov, and N. V. Fedorenko (Inst. of Physics and Tech., Academy of Sciences, USSR and Research Inst. of Electrophysical Apparatus, USSR). Zhur. Tekh. Fiz., 30: 1381-93(Dec. 1960). (In Russian)

A general description is given of the Alpha facility which receives current discharges within its toroidal vacuum chamber. A condenser bank of energy 1.5×10^6 joules supplies an impulse of 2 to 3 msec duration for a discharge in hydrogen with pressure 2×10^{-4} mm Hg in an external magnetic field of 180 to 720 gauss. General results are presented on the electric and magnetic character of the discharge, insertion of probes, microwave and spectrographic investigation, and flow of emitted neutral particles. The character of the discharge in Alpha did not conform to the usual performance of a self-compressing quasi-stable discharge. Several effects were noted in particular: the absence of the formation of kinks, the presence of significant azimuthal current and azimuthal discharge about the magnetic axis, the presence of oscillations and irregular collective movements in the discharge, uneven density distribution in the plasma, and a large number of protons of 10-kev energy. It was felt that an anisotropic-conducting plasma could give appearances of instability and accelerating mechanisms of various types. (TTT)

13857 CONSTRUCTION DATA AND BASIC PARAMETERS OF THE "ALPHA" FACILITY. V. A. Glukhukh, E. G. Komar, B. A. Larionov, I. F. Malyshev, N. A. Monoszon, A. M. Stolov, and N. S. Streltsov (Scientific Research Inst. for Electrophysical Apparatus, Leningrad). Zhur. Tekh. Fiz., 30: 1394-1403(Dec. 1960). (In Russian)

The design of the Alpha facility required the solution of an entire series of engineering problems. The primary requirements were the attainment of maximum discharge current for minimum stored energy in the condenser bank, attainment of high vacuum, prevention of breakdown of the insulating gaps of the vacuum chamber, and the design of a scheme permitting regulation of the applied azimuthal electric field and the time variation of the discharge current. In operation, the facility is essentially a powerful impulse transformer with a secondary winding that is a ring of plasma with variable inductance and resistance. The voltage is applied by means of a figure-8 demountable magnet yoke with primary windings on the central leg. The power is supplied from a 1.5-megajoule condenser bank. The basic parameters of the facility are: mean torus diameter, 3 meters; diameter of a cross section, 1 meter; intensity of the induced field, 0.2 to 8 volts/cm; intensity of the longitudinal magnetic field, 1500 oersteds; maximum discharge current, 300 kiloamperes; weight of iron in the magnet yoke, 110 metric tons; weight of the vacuum chamber, 4.5 metric tons; and complete weight of the facility, 156 metric tons; descriptions are given of over-all circuit design considerations, the impulse transformer, the power distribution system, the preliminary ionizer, and the vacuum system. (TTT)

13858 INVESTIGATION OF ELECTRIC AND MAGNETIC CHARACTERISTICS OF THE DISCHARGE IN THE "ALPHA" FACILITY. V. A. Glukhukh, D. E. Zabarin, E. G. Komar, B. A. Larionov, N. A. Monoszon, V. V. Skotnikov, and A. M. Stolov (Scientific Research Inst. for Electrophysical Apparatus, Leningrad). Zhur. Tekh. Fiz., 30: 1404-14(Dec. 1960). (In Russian)

Data are presented on the gross electrical parameters of the "Alpha" discharge: the time variation of current, voltage, and plasma resistance and the dependence of the maximum current and the plasma resistance on applied voltage and on initial longitudinal magnetic field. A series of magnetic probe studies which led to a complete description of the spatial dependence of the various components of current density and magnetic field are discussed. It is shown that in the course of the discharge the total longitudinal magnetic flux in the chamber grows by a factor as large as 5, depending on initial field and applied voltage. This flux shows strong oscillations in the frequency range 60 to 80 kc. These oscillations also appeared in the current density. The maximum longitudinal magnetic field was much higher than expected from pressure considerations, as was observed elsewhere. The plasma conductivity suggested a maximum electron temperature of 30 ev. The longitudinal component of current density showed several peaks over the discharge diameter. The current channel tended to be centered outward from the magnetic axis. (TTT)

13859 A MEASURE OF THE FLOW OF ENERGY EMITTED FROM THE PLASMA OF THE "ALPHA" FACILITY. V. A. Burtsev, A. M. Stolov, and V. V. Shachov (Inst. of Physics and Tech., Academy of Sciences, USSR and Research Inst. of Electrophysical Apparatus, USSR). Zhur. Tekh. Fiz., 30: 1415-21(Dec. 1960). (In Russian)

The total energy loss by electromagnetic radiation and neutralized energetic particles was measured in the Alpha facility. The energy loss dependence on time and space was investigated for several conditions of pressure and external magnetic field. The measured results accounted for only 10 to 20% of the total amount of energy stored in the plasma created by the discharge. The first bolometer was a nickel spherical black body with a coefficient of absorption equal to unity. It had a weight of 0.1 g and a sensitivity of 10°C/joule and could measure only the integral of the energy loss from the plasma because of its long time constant of 0.5 sec. The second bolometer was a flat-plate detector utilizing a 200-ohm spiraled bismuth thermal resistor of 50 mg and a rise time of 100 μsec. The flat-plate bolometer found the same discrepancy between the power measured and the power introduced. The measurements showed that the bolometers registered only a part of the total energy introduced in the plasma. This indicated that there are localized places which emit significant amounts of energy; this may be a result of oscillating magnetic fields in the discharge. The measurements showed clearly that the emitted energy begins at a time significantly later (1 msec) than the moment of origin of the discharge. (TTT)

13860 SPECTRAL INVESTIGATIONS IN THE "ALPHA" FACILITY. I. STUDY OF THE CHARACTER OF SPECTRA AND ION TEMPERATURES. A. N. Zaĭdel', G. M. Malyshev, E. Ya. Shreider, A. B. Berezin, V. A. Belyaeva, V. I. Gladushchak, V. V. Skidan, and L. V. Sokolova (Inst. of Physics and Tech., Academy of Sciences, USSR and Scientific Research Inst. for Electrophysical Apparatus, USSR). Zhur. Tekh. Fiz., 30: 1422-32(Dec. 1960). (In Russian)

The emission spectrum of the discharge was investigated over the range 350 to 5000 A. Ion temperatures were determined by spectral line broadening. The data on the temperature of impurity ions showed that, depending on the choice of line and the operational conditions of the facility, the measured temperatures varied between 0.5×10^6 and 15×10^6°K. The temperature increased with the charge of the ion being studied. This indicated the independent character of the motion of ions with different charges and also the lack of a unique determination of plasma temperature by the Doppler broadening of impurity lines. (TTT)

13861 SPECTRAL INVESTIGATIONS IN THE "ALPHA" FACILITY. II. DIRECTED MOTION OF THE IONS. A. N. Zaĭdel', G. M. Malyshev, E. I. Moskalev, E. A. Ptitsyna, L. V. Sokolova, and G. I. Chashchina (Inst. of Physics and Tech., Academy of Sciences, USSR and Scientific Research Inst. for Electrophysical Apparatus, USSR). Zhur. Tekh. Fiz., 30: 1433-6(Dec. 1960). (In Russian)

The displacement of spectral lines was used to determine the direction of ionic motion along the axis of the discharge in the Alpha facility. The speed of the ordered motions did not exceed 10^6 cm/sec. The speed of the ordered motion grew with the increase of an ion's charge, being always 5 to 10% of its thermal velocity. (TTT)

13862 SPECTRAL INVESTIGATIONS IN THE "ALPHA" FACILITY. III. TIME CHARACTERISTICS OF THE PLASMA EMISSION. A. N. Zaĭdel', G. M. Malyshev, A. B. Berezin, and G. T. Razdobarin (Inst. of Physics and Tech., Academy of Sciences, USSR and Scientific Research Inst. for Electrophysical Apparatus, USSR). Zhur. Tekh. Fiz., 30: 1437-46(Dec. 1960). (In Russian)

A method for the mechanical scanning of a spectrum, oscillography of individual spectral lines, and investigation of ordered motion of ions, with the help of the separation of resolved halves of spectral lines are described. Data were found concerning the time dependence of the broadening and intensity of spectral lines. Ordered motion was detected for the ions N(IV). (TTT)

13863 MICROWAVE INVESTIGATIONS OF THE PLASMA IN THE "ALPHA" FACILITY. V. A. Anoshkin, V. E. Golant, B. P. Konstantinov, B. P. Poloskin, and O. N. Shcherbinin (Inst. of Physics and Tech., Academy of Sciences, USSR and Scientific Research Inst. for Electrophysical Apparatus, USSR). Zhur. Tekh. Fiz., 30: 1447-55(Dec. 1960). (In Russian)

Results are presented of investigations of the plasma in the Alpha facility, conducted by probing it with 3-cm and 8-mm radio waves. Reflection and transmission measurements were used to follow the motion of certain density contours and the time at which the plasma density exceeded the critical one for transmission. The plasma density appeared to grow most rapidly near the outer wall of the torus. The center of gravity of the plasma seemed to lie outward from the magnetic axis. The data were complicated by complex oscillation phenomena. (TTT)

13864 A METHOD FOR INVESTIGATION OF THE FLOW OF ATOMS EMITTED FROM A PLASMA. V. V. Afrosimov, I. P. Gladkovskiĭ, Yu. S. Gordeev, I. F. Kalinkevich, and N. V. Fedorenko (Inst. of Physics and Tech., Academy of Sciences, Leningrad). Zhur. Tekh. Fiz., 30: 1456-68(Dec. 1960). (In Russian)

A method is described in which the uncharged atomic particles leaving the impulse Alpha facility are analyzed for intensity, energy dependence, time of occurrence, and mass. The uncharged particles leaving the plasma of Alpha enter a collimating slit system which defines the geometry; electrostatic plates permit only neutral particles to enter a gas cell with pressure of nitrogen of 10^{-4} mm Hg. Here ionization of the neutrals takes place and the emerging charged particles are swept onto a target. The secondary electrons emitted from this target are accelerated to 10 kev and then strike a scintillation crystal where a photomultiplier counts the number of particles. The sensitivity of this instrument was found by using an independent ion source and accelerating system; the coefficient for ionization and the integral and differential amplitude of the impulse were found, along with the saturation for accelerating voltage and the energy dependence. The method is useful over the energy range 250 ev to 40 kev. Circuits are outlined which give oscillographs of energy distribution, of the time dependence of particles with respect to original impulse, and analysis of mass by time of flight. Calculations are also given which relate the measured parameters to the internal plasma parameters: the energy distribution of the impulse, the density within the plasma, and the type of emerging particle. (TTT)

13865 INVESTIGATION OF THE FLOW OF NEUTRAL ATOMIC PARTICLES EMITTED BY THE PLASMA OF THE ALPHA FACILITY. V. V. Afrosimov, I. P. Gladkovskiĭ, Yu. S. Gordeev, I. F. Kalinkevich, M. P. Petrov, and N. V. Fedorenko (Inst. of Physics and Tech., Academy of Sciences, USSR and Research Inst. for Electrophysical Apparatus, USSR). Zhur. Tekh. Fiz., 30: 1469-84(Dec. 1960). (In Russian)

The energy dependence of the atomic particles leaving the Alpha facility upon loop voltage, magnetic field, and pressure was measured. Practically all the particles leaving were hydrogen atoms. The energy distributions were normalized at 500 ev and the energy range extended from 300 ev to 10 kev. The number of fast particles increased with increasing loop voltage but decreased with increasing magnetic field or increasing pressure. For a group of particles with average energy of 400 ev the time dependence showed that as the loop voltage was increased one pulse of particles occurring at the same time as the impulse maximum spread into two pulses, one at the beginning and one at the end of the impulse. For higher fields the time interval between the maxima of the two pulses decreased. For higher pressures the first pulse decreased in amplitude whereas the second remain constant. The results were similar for other groups with higher average energy. The density of atoms of energies 300 ev to 10 kev varied from 10^9 to 7×10^{10} atoms/cm^3 or 10^{-4} to 5×10^{-3} of the density of ions in the plasma. The energy of the atoms having energy greater than 300 ev represented 5 to 13% of the total energy available. The current of fast atoms was caused by the charge exchange of fast ions within the discharge. The energy distribution could not be approximated by a Maxwellian distribution. (TTT)

13866 ON THE ENERGY DISTRIBUTION OF FAST NEUTRAL ATOMS EMITTED FROM A PLASMA. O. V. Konstantinov and V. I. Perel' (Inst. of Physics and Tech., Academy of Sciences, Leningrad). Zhur. Tekh. Fiz., 30: 1485-8(Dec. 1960). (In Russian)

The method of calculation of Zubarev and Klimov was generalized to determine the explicit relation between the measured external current and energy of the atoms emitted from the Alpha plasma and the internal density and energy of the ions within the plasma. The relation expressing the concentration of ions was calculated, as well as the current of atoms leaving the plasma. This external current was expressed in three parts: ions charge exchanging on the primary current, equilibrium current due to many such charge exchanging collisions, and recombination of ions on the wall and their subsequent emission. The latter was important only for fast ions. The correlation between the equilibrium current and the recombination determined the character of reflection of fast particles from the walls. The albedo of the plasma was also calculated and agreed with the expression found by Zubarev and Klimov. (TTT)

13867 UBER ELEKTRISCHE MIKROUBERSCHLAGE IN VAKUUM. (Electric Microdischarges in Vacuum). Siegfried Wiesner. Thesis, Berlin, Technische Universität, 1960. 78p.

Between electrodes at 10^{-3} to 10^{-4} torr, electric dis-

charges appear in the form of local confined spark and microdischarges. By means of many small current-limited spark discharges, it is shown that below a certain anode potential only microdischarges are observed. For the plane-parallel V2A electrodes used, this potential is 45 kv at 1 mm. These microdischarges were studied by several methods. Oscillographic traces during a microdischarge show a characteristic current and potential course. As a criterion for the appearance of microdischarges, a threshold potential is defined. On a special electrode system, the effects of changes of coating on the electrode surface on the microdischarges are confirmed. Quartz oscillation measurements show that an increase in the mass coating occurs. Charge transport in microdischarges occurs mainly by electrons and H^+ ions. Other results are described and discussed. (T.R.H.)

13868 CONTINUOUS PLASMA GENERATOR. (to U. S. Atomic Energy Commission). British Patent 862,900. Mar. 15, 1961.

A continuous plasma generator is designed which employs a magnetic field gradient to control the plasma output. The generator consists of a cylindrical anode with a first electrode adjacent at one end and a second electrode at the other end. A gas is introduced to the inside of the anode where it is ionized. A magnetic field established axially through the anode restrains the ions from impinging the anode and urges them from the anode through an aperture in the second electrode for the continuous ejection of plasma. (D.L.C.)

Shielding

13869 (NARF-60-21T) ASTR FAST-NEUTRON AND GAMMA-RAY SPECTRAL MEASUREMENTS. A. N. Gabro and L. G. Mooney (Convair, Fort Worth, Tex.). Jan. 15, 1961. Contract AF33(600)-38946. 64p. (MR-N-263)

Gamma and fast-neutron radiation spectra from the Airborne Shield Test Reactor (ASTR) are determined. Gamma-ray spectral measurements are presented for the following experimental arrangements: (1) In a horizontal plane through the centerline of the ASTR, at $\theta = 0°$ through 180°, at a 63-ft separation distance, for ASTR configuration 3 with the boral cover on the ASTR and the ASTR shield water borated, and using a collimated detector; and (2) in the small cylinder (geometry D), at $\theta = 0°$ at a 33-ft separation distance, for ASTR configuration 3 with the boral cover off the ASTR and the ASTR shield water not borated, and using a bare-crystal uncollimated detector. Fast-neutron spectral measurements were made in a horizontal plane through the centerline of the ASTR at a 33-ft separation distance, and are presented for: (1) $\theta = 0$, 105, and 120° for ASTR configuration 3; (2) $\theta = 105°$ for ASTR configuration 5; and (3) $\theta = 90°$ for ASTR configuration 15. (auth)

13870 (TID-11570) SHIELDING COMPUTER PROGRAM 19-0, FAST NEUTRON REMOVAL CROSS SECTION COMPUTATION (ANP PROGRAM NO. 514). K. B. Hanchon and M. L. Pope (General Electric Co. Aircraft Nuclear Propulsion Dept., Cnicinnati). Oct. 4, 1960. Contracts AF 33(600)-38062 and AT(11-1)-171. 31p. (XDC-60-10-133)

Shielding Computer Program 19-0 computes fast-neutron effective-removal cross sections for those calculations of fast-neutron penetration that combine an influence function of the Albert-Welton form with an integration over a disk or cylindrical source. The cross sections thus calculated may be considered as functions of input dose rates, material thickness and configuration, thickness of backing material, and source-receiver distance. Program 19-0 includes the following iterative capability; once the fast-neutron effective-removal cross section for a given material has been computed, that material may be regarded as a "backing material" and used in the computation of the fast-neutron effective-removal cross section of an inserted material. (auth)

13871 (TID-11572) SOLID STATE PHYSICS SERIES: FISSION FRAGMENT RECOIL LOSS FROM TWO-REGION ARRAYS OF SLABS AND CYLINDERS. J. R. Beeler (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Aug. 1960. Contracts AF 33(600)-38062 and AT (11-1)-171. 26p. (XDC-60-11-83)

The fixed range, isotropic source model was used to estimate the fission-fragment absorption distribution in two-region systems with slab and cylindrical geometry. The slab system was composed of alternate layers of solid material and streaming fluid, and the cylindrical system was composed of a solid matrix containing circular cylinders of streaming fluid. The fragment source was assumed to reside in solid material. The fraction of all particles emitted, FA, which is absorbed in the fluid region, is proportional to the reentry attenuation factor, β, which measures that part of all particles entering the fluid which cross through it and enter solid material. For cylindrical fluid regions, $\beta = 2r/R_f$, where r is the cylinder radius and R_f the particle range in the fluid over a wide range of cylinder radius and particle range values. For slab systems, $\beta = (1 - (1 - t/R_f)^2)$, where t is the thickness of the fluid layer. (auth)

13872 (TID-11681) SPECIALIZED REACTOR-SHIELD MONTE CARLO PROGRAM 18-0. J. E. MacDonald, J. T. Martin, and J. P. Yalch (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Jan. 13, 1961. Contracts AF33(600)-38062 and AT(11-1)-171. 117p. (XDC-61-1-91)

Specialized Monte Carlo Program 18-0, GE-ANPD Program 349, is a digital computer program that applies Monte Carlo methods to simulate neutron and γ-ray life histories in reactor-shield assemblies. The code is specialized to provide only as much geometry and importance sampling capabilities as are needed for analysis of selected reactor-shield systems. Specialization in these areas results in a more efficient code for analysis of reactor-shield systems than can be achieved by application of more general-purpose Monte Carlo codes. The program is coded for an IBM-704 with a fast memory capacity of 32,768 storage locations. Seven magnetic tape units are required, but no magnetic drum storage is necessary. (auth)

13873 CRITERIA INHERENT TO THE BASIC CALCULATION OF PRIMARY SHIELDINGS FOR NUCLEAR REACTORS. Germano Polano. Ing. nucleare, 3: 239-46 (Nov.-Dec. 1960). (In Italian)

In order to limit as far as possible the work required in the calculation of shielding initial projects must rest on semi-empirical methods, offering sufficiently precise data to enable decisions as to types of shielding to employ. Considering the fact that the primary shielding must reduce neutron speed and gamma radiations, methods are given for calculating attenuation of the fast neutron flux; thermal neutron flux needed for the evaluation of the captured gammas; attenuation of the gammas. (auth)

13874 IMPROVEMENTS IN OR RELATING TO MATERIALS FOR SHIELDING AGAINST RADIATION. (to Metallwerk Plansee Gesellschaft m.b.H.). British Patent 861,657. Feb. 22, 1961.

A simple method is given for manufacturing a uranium–tungsten alloy material for use as a shielding material in radioisotope containers. This method consists in compressing tungsten powder on or as the container and impregnating the compressed tungsten powder with molten uranium or a molten uranium alloy in vacuum or an inert atmosphere. The materials obtained have a density of ~19 g/cm^3 and have good machinability. It is possible to produce materials with a uranium content up to ~40% (using tungsten with 40% voids). (D.L.C.)

13875 METHOD FOR MAKING LEAD SHIELDS. (to Knapp Mills Inc.). British Patent 862,571. Mar. 15, 1961.

A method is given for making lead and lead alloy shields of uniform density and free from voids, shrink cavities, and similar defects. In this method, a layer of molten lead is placed in an enclosure and cooled from underneath to solidify the bottom progressively, the top surface being kept molten by heating with torches. The condition of the surface of the solidified lead covered by molten lead is determined with probes, and more molten lead can be added at intervals to give the desired depth. In this way, it is possible to make lead shields of any thickness without fear of defects or cavities. Enclosures for making various lead shapes, including one for a container, are described. (D.L.C.)

Theoretical Physics

13876 (CERN-60-40) SYMMETRY PROPERTIES OF PARTICLES AND FIELDS. F. Mandl (European Organization for Nuclear Research, Geneva). Oct. 21, 1960. 115p.

A series of lectures on the symmetry properties of quantum mechanical systems is presented. Topics covered include perturbation theory; closed-form expressions for scattering amplitudes; symmetries, invariance properties, and conservation laws; inversion; charge conjugation; time reversal; TCP theorem; isospace; strange particles; and inversion in isospace. (W.D.M.)

13877 ON THE BETHE-SALPETER METHOD IN THE THIRRING MODEL. K. Ladanyi (Hungarian Academy of Science, Budapest). Acta Phys. Acad. Sci. Hung., 12: 199-204(1960). (In English)

The Bethe–Salpeter equation of the time-ordered two-particle amplitude in the Thirring model is solved in ladder approximation. It is shown that the correct antisymmetrical solution appreciably differs from the amplitude derived by Scarf. (auth)

13878 ON THE "NEW TAMM-DANCOFF" APPROXIMATION TREATMENT OF THE SUPERCONDUCTIVITY HAMILTONIAN. Kazuo Yamazaki (Max-Planck-Inst. fur Physik and Astrophysik, Munich). Nuclear Phys., 23: 139-43(Feb. 1961). (In English)

The "new Tamm-Dancoff" approximation method is applied, in the same form as that used in Heisenberg's theory of elementary particles, to Bardeen's reduced Hamiltonian for the theory of superconductivity. (auth)

13879 GROUP THEORY OF HARMONIC OSCILLATORS. II. THE INTEGRALS OF MOTION FOR THE QUADRUPOLE-QUADRUPOLE INTERACTION. V. Bargmann (Princeton Univ., N. J.) and M. Moshinsky. Nuclear Phys., 23: 177-99(Feb. 1961). (In English)

Integrals of motion are obtained which are associated with a system of N particles moving in a common harmonic oscillator potential and having a quadrupole-quadrupole interaction. The eigenvalues of these 3N integrals of motion are obtained by applying the corresponding operators to the reduced canonical wave function. The reduced canonical wave function is constructed explicitly, and it is shown to give a basis for all the irreducible representations of the three dimensional unitary unimodular group. One of the integrals of motion obtained is essentially the quadrupole moment projected along the direction of the angular momentum, and its eigenvalues are discussed in detail. (auth)

13880 SHELL-MODEL ANALYSIS OF CALCIUM ISOTOPES. Henri E. Mitler (Brandeis Univ., Waltham, Mass.). Nuclear Phys., 23: 200-44(Feb. 1961). (In English)

An intermediate shell model calculation is made for Ca^{42} and Ca^{43}. The effective two-body (static) internucleon potential, acting among the neutrons outside the Ca^{40} core, is phenomenologically obtained by fitting the known energy levels of Ca^{42} and Ca^{43}. The fit to eight levels is fair, the rms deviation being 124 kev. The potential is found to differ strongly from that expected from nucleon-nucleon scattering experiments: it is long-ranged instead of short-ranged, has a weak repulsive (rather than attractive) triplet odd part, and has a strong, attractive (rather than weak, repulsive) tensor part. The fit to the energy levels is nevertheless better than that for previous calculations. A comparison of the calculated electromagnetic transition probabilities indicates a considerable amount of surface-particle coupling, indicating a strong admixture of one of the core states. A theorem is derived which facilitates computation of tensor-force matrix elements in j–j coupling. (auth)

13881 CANONICAL AND NON-CANONICAL METHOD OF QUANTISATION IN THE LEE MODEL. Katsuhiko Sekine (Max-Planck-Institut für Physik und Astrophysik, Munich). Nuclear Phys., 23: 245-68(Feb. 1961). (In English)

The connection between the canonical and the non-canonical method of quantization is studied with the help of the Lee model with indefinite metric. It is shown that, even when the anticommutator vanishes for equal times, it is still possible to construct a Hamiltonian formalism similar to the conventional one by introducing a small time interval, Δt, into some basic relations of the theory. (auth)

13882 NOTES ON THE THEORY OF VIBRATIONAL STATES OF SYSTEMS OF FERMIONS. [PART] I. J. Sawicki (California Univ., Berkeley). Nuclear Phys., 23: 285-95(Feb. 1961). (In English)

The system of nonlinear equations for the components of the single-particle density-matrix operator is discussed for both infinite and finite systems of fermions interacting through a two-body residual interaction. The Hartree-Fock factorization and linearization of that system of equations for the density fluctuations can be performed. Hartree-Fock exchange terms and, particularly, deviations from the random phase approximation are discussed. The importance of these deviations is illustrated by the example of the quadrupole vibrations of a closed spherical nuclear subshell. An apparent ambiguity in the linearization procedure is discussed, and the importance of the nonlinearity of equations is stressed. (auth)

13883 CONVERGENCE OF THE CLUSTER EXPANSION FOR THE OPTICAL MODEL POTENTIAL. P. B. Jones (Clarendon Lab., Oxford). Nuclear Phys., 23: 349-52(Feb. 1961). (In English)

The convergence of the cluster expansion for the optical model potential is examined at low energies by comparison of the series with the potential given by a closed form. The problem of antisymmetrization is not considered. (auth)

13884 QUANTUM MECHANICS AND THE UNIQUENESS OF THE WORLD. B. Bertotti (Princeton Univ., N. J.). Nuovo cimento (10), 17: Suppl. No. 1, 1-7(1960). (In English)

The theory of quantum mechanics and its relation to the basic datum of everyday life, the uniqueness of the world, is discussed. The stochastic model of knowledge offered by both classical and quantum physics is described. Questions are raised about the adequacy and logical clarity of quantum mechanics. (M.C.G.)

13885 QUANTUM-MECHANICAL MANY-PARTICLE TREATMENT OF SOUND PROPAGATION. D. E. McCumber (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo cimento (10), 17: Suppl. No. 1, 8-42 (1960). (In English)

A quantum-mechanical treatment of the problem of sound propagation is discussed. The relevant features of a field theoretic many-particle formalism applicable to the problem are summarized. The special formal relations which apply in the treatment of transport properties and sound propagation are presented. Exact and approximate integral equations for the density correlation function or sound propagator are discussed. In developing approximate equations, the time-invariance properties that result from the fact that many relevant macroscopic operators commute with the Hamiltonian were taken into account. It is shown that the mechanism for sound propagation can vary from system to system. It was observed than in "perfect" gases sound propagation is related to single-particle damping, a second-order effect. A second-order Boltzmann-like equation was obtained by the general approximation technique and solved for the perfect-gas case. (M.C.G.)

13886 INDEFINITE METRIC IN QUANTUM FIELD THEORY. K. L. Nagy (Universita, Rome). Nuovo cimento (10), 17: Suppl. No. 1, 92-131(1960). (In English)

The quantization of field theory by introduction of an indefinite metric is discussed. A mathematical introduction to the properties of a vector space with an indefinite metric is presented. The method for obtaining a theory with indefinite metric is described. The ghost-state contributions appearing in the spectral representation of the propagators were studied. (M.C.G.)

13887 THEORY OF THE DE HAAS-VAN ALPHEN EFFECT FOR A SYSTEM OF INTERACTING FERMIONS. J. M. Luttinger (Columbia Univ., New York). Phys. Rev., 121: 1251-8(Mar. 1, 1961).

The de Haas-van Alphen effect for a system of interacting fermions was investigated. It is shown that, granting certain analytic properties, it is possible to obtain a simple expression for the oscillatory part of the thermodynamic potential. In particular, it is found that the de Haas-van Alphen oscillations have the same amplitude and period as in the usual quasi-particle picture, but that the phase is given by a more complicated procedure. (auth)

13888 QUANTUM-CORRECTED STATISTICAL METHOD FOR MANY-PARTICLE SYSTEMS: THE DENSITY MATRIX. L. C. R. Alfred (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 121: 1275-82(Mar. 1, 1961).

Quantum corrections are obtained for the single-particle density matrix in a semiclassical ensemble where the distribution is unrestricted. A form for the density matrix containing explicitly a function of the wave-mechanical hamiltonian operator is devised; a formalism is then developed to decompose this operator function into effectively classical and nonclassical parts. The classical part corresponds to the semiclassical density matrix and the quantum corrections are obtained from the nonclassical terms. The quantum-corrected density matrix for a spherically symmetrical and a one-dimensional system are evaluated. The densities for a linear harmonic oscillator and a Coulomb potential for a Fermi-Dirac distribution are examined in some detail. (auth)

13889 WAVE ZONE IN GENERAL RELATIVITY. R. Arnowitt, S. Deser, and C. W. Misner (Syracuse Univ., N. Y. and Brandeis Univ., Waltham, Mass.). Phys. Rev., 121: 1556-66(Mar. 1, 1961).

It is shown that in general relativity a "wave zone" may be defined for systems that are asymptotically flat. In this region, gravitational radiation propagates freely, independent of its interior sources, and obeys the superposition principle. The independent dynamical variables of the full theory, which describe the radiation, are shown to be coordinate invariant in the wave zone and to satisfy the linearized theory's equations there. Thus, the basic properties of free waves in linear field theories (e.g., electrodynamics) are reproduced for the gravitational case. True waves are also clearly distinguished from so-called "coordinate waves." Reduction to asymptotic form (taking leading powers of 1/r), is not identical to linearization, since, for example, the Newtonian-like 1/r part of the metric begins quadratically in the linear theory's variables. The Poynting vector of the full theory, which measures energy flux in the wave zone, is correspondingly shown to be given by the linearized theory's formula. This Poynting vector is also shown to be coordinate-invariant in the wave zone. All the physical quantities may therefore be evaluated in any frame becoming rectangular sufficiently rapidly. A brief discussion of measurements of the canonical variables in the wave zone is given. (auth)

13890 PROOF OF THE MANDELSTAM REPRESENTATION FOR EVERY ORDER IN PERTURBATION THEORY. Richard J. Eden (Cambridge Univ., Eng.). Phys. Rev., 121: 1567-76(Mar. 1, 1961).

It is proved that every term in the perturbation series for a scattering amplitude satisfies the Mandelstam representation when there are no anomalous thresholds. The absence of anomalous thresholds can be investigated from a few low-order diagrams or reduced diagrams. Under certain conditions it is shown that their absence in fourth order ensures their absence in every order. (auth)

13891 QUADRATIC LAGRANGIANS AND GAUGE-INVARIANCE IN COVARIANT FIELD THEORIES. G. Stephenson (Imperial Coll., London). Proc. Cambridge Phil. Soc., 56: 247-51(July 1960).

Gauge-invariant variational principles formed from Lagrangians quadratic in the Riemann-Christoffel curvature tensor and its contractions were examined. Both g_{ik} and Γ^{i}_{lk} were allowed to be nonsymmetric, as in the generalization of general relativity due to Einstein and Schrödinger. These quadratic Lagrangians were invariant under the extended Weyl type gauge-transformation, and therefore a class of theories were obtained which were gauge-invariant generalizations of the Einstein–Schrödinger theory. The equations and method of formulation of the nonsymmetric theory are given. (M.C.G.)

13892 THE QUASI-PARTICLE APPROXIMATION IN SUPERCONDUCTIVITY. P. G. Harper (National Standards Lab., Sydney). Proc. Phys. Soc. (London), 77: 299-302 (Feb. 1, 1961).

A derivation of the Bardeen, Cooper and Schrieffer and the Bogoliubov secular equations by a common method shows that it is necessary to neglect a large number, proportional to V^{n}, of small matrix elements, proportional to V^{-n}, where V is the volume of the system and n an arbitrary positive integer. A generalization of the Bogoliubov ferm-

ion transformation which diagonalizes these terms takes the form of an infinite series whose convergence may depend on the form of the interaction. (auth)

13893 AN APPROXIMATE METHOD FOR THE CALCULATION OF MULTIPOLE POLARIZABILITIES OF ATOMS. A. L. Stewart (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 77: 447-50(Feb. 1, 1961).

The method devised by Vinti is modified to calculate values of the multipole polarizabilities and nuclear quadrupole shielding factors of the two electron systems. The results are used to compute the long-range interaction energy curve for a proton and a helium atom. (auth)

13894 A LATTICE MODEL OF A CLASSICAL HARD SPHERE GAS: [PART] II. D. M. Burley (Univ. of Glasgow). Proc. Phys. Soc. (London), 77: 451-8(Feb. 1, 1961).

The antiferromagnetic Ising model can be transformed into a model of a hard-sphere lattice gas. For the model on the loss packed lattices, a transition from an ordered to a disordered phase was suggested; however, no firm results could be obtained, since the approximation used for the ordered phase was inadequate. The pressure and free energy curves of both phases can be calculated on the Bethe and "ring" approximations. In each case a transition of the second order occurs. (auth)

13895 A PERTURBATION-VARIATION CALCULATION OF EIGENVALUES. A. Dalgarno and A. L. Stewart (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 77: 467-70(Feb. 1, 1961).

A variational method, based upon perturbation theory, was used to calculate the eigenvalues of the helium sequence. With a trial wave function containing essentially only one variable parameter, the resulting errors ranged from 0.3 ev for H^- to 0.01 ev for Ne^{8+}. (auth)

13896 SOME NOTES ON THEORIES OF HELIUM. F. J. Pearson (Lanchester Coll. of Tech., Coventry, Eng.). Proc. Phys. Soc. (London), 77: 531-49(Feb. 1, 1961).

An approximation to the quantum mechanical partition function for an imperfect fluid that is afforded by assuming the commutation of the kinetic and potential energy operators is discussed. The corresponding grand partition function is developed in the form of a cluster integral series, and discussion of its behavior at low temperature is facilitated by a further approximation. This leads to equations for the pressure and density which afford a qualitative description of the condensation of helium into liquids I and II. Numerical calculations show not unreasonable agreement with experiment. The theories of Chester and Feynman are discussed in detail in relation to cluster integral expansions. (auth)

13897 ON THE VALIDITY OF TWO CONJECTURES RELATING TO RESONANCE COLLISIONS. B. G. Skinner (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 77: 551-3(Feb. 1, 1961).

The Gurnee-Magee and Rosen-Zener proposed solutions to the coupled differential equations for collisions at or near resonance are compared. Solutions are integrated numerically on a DEUCE computer using a four-stage Runge-Kutta method. The proposed solutions are compared with the computer solutions. Results indicate that the Rosen-Zener solution is more accurate over a wider range than the Gurnee-Magee solution. (T.F.H.)

13898 ON THE SCREENING OF MAGNETIC INTERACTION BY DEGENERATE FREE ELECTRONS. Noboru Takimoto (Tohoku Univ., Sendia). Progr. Theoret. Phys. (Kyoto), 24: 923-48(Nov. 1960). (In English)

A detailed investigation was made on the self-consistent determination of the vector potential due to a magnetic point dipole imbedded in a medium of degenerate free electrons. The Thomas-Fermi method shows that the screening by an induced electric current is Landau-diamagnetic, and practically negligible. A dynamical method is then applied to the same problem to investigate the effect of a flip motion of the point dipole on the screening. In this case another type of screening arises which is due to the inability of some electrons to follow the nonadiabatic change of force induced by the flip motion. The derived potential is used for the calculation of the spin-lattice relaxation time in ferromagnetic metals, and Kasuya's estimation of its order of magnitude is proved to be reasonable. Some discussion is also given of its temperature dependence. (auth)

13899 MACROSCOPIC CAUSALITY AND LOWER LIMIT FOR THE MOMENTUM DERIVATIVE OF THE SCATTERING PHASE SHIFT. Takesi Ogimoto (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 24: 949-52(Nov. 1960). (In English)

On the basis of macroscopic causality in quantum field theory some investigations are made for a lower bound of the momentum derivative of the scattering phase shift. (auth)

13900 COLLECTIVE REPRESENTATION OF THE MANY-PARTICLE SYSTEM INTERACTING THROUGH ARBITRARY TWO-BODY POTENTIAL. Naomi Shohno (Hiroshima Jogakuin Coll.). Progr. Theoret. Phys. (Kyoto), 24: 991-1012(Nov. 1960). (In English)

A collective description is developed for a many-particle system interacting through an arbitrary two-body potential. The description is given both in terms of the second quantized form and in terms of an auxiliary field analogous to the longitudinal electromagnetic field. Since the Bohm-Pines theory of the collective description has some unsatisfactory features concerning the subsidiary condition imposed on the auxiliary field, a strict method is proposed for the treatment of the subsidiary condition. To obtain the useful result of the collective representation, the three steps of the canonical transformations must be taken. Although the first two transformations are the same as those of Bohm-Pines, the third transformation, which is not applied by Bohm-Pines and is characteristic of the present theory, is necessary for obtaining a meaningful result. By using both the strict subsidiary condition and the three canonical transformations, the collective field coordinate and the particle coordinate are separated not only in the total Hamiltonian but also in the subsidiary condition. Moreover, clarity is obtained for the correct meaning of the subsidiary condition. (auth)

13901 ON RADIATIVE CORRECTIONS DUE TO SOFT PHOTONS. Toshiyuki Murota (Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 24: 1109-17(Nov. 1960). (In English)

It is shown that the contribution from soft photons can be taken exactly into account in the calculation of any S-matrix. The conditions are examined under which the contribution from soft photons to cross sections is factorized. (auth)

13902 APPLICATIONS OF MELLIN TRANSFORMS TO SOME PROBLEMS OF STATISTICAL MECHANICS. Giiti Iwata (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 24: 1118-22(Nov. 1960). (In English)

Mellin transforms are used to obtain an asymptotic form of an integral containing a power series, in which the term by term integration cannot be allowed. Examples are given concerning problems of statistical mechanics, e.g., the partition function of an electron gas, the correlation energy of a free electron gas, and the partition function of a hard sphere gas at zero-temperature limit. (auth)

13903 EFFECT OF THE PARTICLE-HOLE PAIR INTERACTIONS IN NUCLEAR MANY-BODY PROBLEM. Masaru Yasuno (Kobayashi Inst. for Physical Research, Tokyo). Progr. Theoret. Phys. (Kyoto), 24: 1129-31(Nov. 1960). (In English)

The dynamical aspects of nuclear particle-hole pairs are studied in many-body nuclear systems. The method used is adapted from plasma particle-hole pair interaction methods. It is shown that the particle-hole pair interaction screens the Fourier component of the Coulomb forces so that the probability of low-momentum-transfer interactions is increased. It is concluded that the pair interaction increases the range of nuclear interactions. (T.F.H.)

13904 THEORY OF FIELD IN A FIVE-DIMENSIONAL SPACE. Yasuhisa Murai (Saitama Univ., Urawa, Japan). Sci. Repts. Saitama Univ., Ser. A., 3: 155-65(1960). (In English)

In a five-dimensional space, the quantization of a field yielded the creation and annihilation operators for the field quanta of variable momenta and variable masses. When the expansion of the S matrix was performed, this feature introduced an extra integration over mass of intermediate quantum. As a preliminary to the study of the interacting fields, the quantization of the free field (both boson and fermion fields) is shown together with the exposition of the basic formula of the five-dimensional theory. (auth)

13905 VIBRATIONAL TRANSITION IN MOLECULAR COLLISION. IV. ANOTHER SHORT TABLE OF FUNCTIONS USEFUL FOR CALCULATING THE VIBRATIONAL TRANSITION PROBABILITY. (PART 1). Kazu Takayanagi (Saitama Univ., Urawa, Japan) and Shobu Kaneko. Sci. Repts. Saitama Univ., Ser. A., 3: 167-78(1960). (In English)

The energy dependence of the vibrational transition cross section comes mainly from the translational matrix element. This energy-dependent factor, averaged over the Maxwellian velocity distribution, is tabulated. The matrix elements of the intermolecular potential with respect to the vibrational eigenfunctions were assumed to be of the Morse type. (auth)

REACTOR TECHNOLOGY

General and Miscellaneous

13906 (ANL-6160) EXAMINATION OF AN IRRADIATED PROTOTYPE FUEL ELEMENT FOR THE ELK RIVER REACTOR. L. A. Neimark (Argonne National Lab., Ill.). Jan. 1961. Contract W-31-109-eng-38. 19p.

An examination was made of a prototype Elk River Reactor fuel element irradiated in the EBWR to a maximum burn-up of 1000 Mwd(t). The assembly, which consisted of an array of type 304 stainless-steel tubes fueled with pellets of 97 wt.% ThO_2-3 wt.% UO_2, showed insignificant dimensional changes. Irregular vertical packing of the fuel pellets gave a "banded" appearance to the fuel rods because of preferential oxide deposition. The brazing material used in the center strap of the assembly showed noticeable corrosion effects. The fuel pellets showed no thermal effects and exhibited little cracking. The dimensional stability was excellent. The fuel exhibited good gas-retention characteristics. (auth)

13907 (ANL-6176) DETERMINATION OF LATTICE PARAMETERS WITH THE AID OF A COMPUTER. Final Report of Metallurgy Program 4.1.8. Melvin H. Mueller and LeRoy Heaton (Argonne National Lab., Ill.). Jan. 1961. Contract W-31-109-eng-38. 29p.

The determination of precision lattice parameters using a least-squares analytical treatment has been programmed into a computer. Although it was originally coded for the Argonne AVIDAC and GEORGE computers, it is now programmed for the IBM 704. The present program permits the determination of lattice parameters and standard errors for the orthorhombic system and for all other crystal systems of higher symmetry. The angular measurements of line positions from a Debye-Scherrer or symmetrical focusing camera or a diffractometer may be given in degrees or radians from several different wavelengths. Provision was made for using as many as three separate correction terms for eccentricity, absorption, divergence, and others; however, one, two, three, or none at all, may be used. The exact trigonometric function or functions used in these correction terms may be selected from several of those previously suggested. If desired, a weighting factor may also be used for each reflection which may include an observation weight or trigonometric function or both. Examples will be given of lattice parameters obtained for various crystal systems using different correction terms with and without weighting. (auth)

13908 (ANL-6293) AN ANALOGUE SOLUTION OF A REACTOR PERTURBATION INITIATED BY A METALLURGICAL PHASE TRANSFORMATION OF THE FUEL. Lawrence T. Bryant, Joseph C. Carter, and Marion J. Janicke (Argonne National Lab., Ill.). Jan. 1961. Contract W-31-109-eng-38. 40p.

The analysis of a reactor model that is thermally nonlinear is presented. The significant sources of feedback in the closed-loop model are dilatational changes of the fuel due to axial expansion caused by temperature and metallurgical phase changes. The dynamics of this phenomenon has been represented on the Pace electronic analog computer. The model was subjected to unusually large inputs of sinusoidal power and did not show any drastic tendencies toward being unstable. (auth)

13909 (APDA-133) FAST REACTOR CORE DESIGN PARAMETER STUDY. (Atomic Power Development Associates, Inc., Detroit). Mar. 1960. Contract AT(11-1)-800. 321p.

Parametric studies of 11 fast reactor fuel systems were made to determine the important design and economic factors on which the cost of producing electric power depend. Some of the studies were applied to a U^{235}-fueled fast reactor and others to a plutonium-fueled fast reactor. The method used consisted of designing a number of cores of different characteristics for use in the reactor power plant and calculating the fixed charges and fuel cycle costs for each design, using the values for fuel burn-up, fabrication costs, and aqueous reprocessing costs developed as part of the studies. Thermal considerations influenced both the core designs and economics to a greater extent than any other factor. It was found that the general method of approach to parametric studies is very important. When a variable was treated independently, a larger variation in results was obtained than actually existed. Fixed charges and total power costs decreased as plant size was increased. Fuel cycle costs increased with coolant temperature. There appeared to be an optimum power density for each fuel system studied. An optimum pressure drop per unit length of core was observed. It was found that if the burn-up could be increased for a given design, the total power cost would be decreased. For fuel systems where clad thickness determined permissible burn-up, there was a broad range of clad thickness for which almost no effect on total power costs was noted. For fuel elements whose burn-up was independent of clad thickness, increased volume of cladding resulted in increased total power costs. A high fuel volume fraction was achieved with plates rather than pins for the same temperature burn-up conditions. Power costs were relatively unchanged by variations within the ranges of uncertainties of nuclear constants such as cross sections. (auth)

13910 (BMI-1503) NUMERICAL SOLUTION OF REACTOR STRESS PROBLEMS. Robert F. Redmond, Lewis E. Hulbert, and Richard W. Clark (Battelle Memorial Inst., Columbus, Ohio). Feb. 28, 1961. Contract W-7405-eng-92. 54p.

Generalized computer codes were devised for solving stress problems of some complexity. These codes were applied to stress problems relating to the graphite moderator elements in the Experimental Gas-cooled Reactor. The stress relief obtained by subdividing the moderator elements was evaluated. The distortion and bending moments of the elements were also determined. (auth)

13911 (CF-60-10-46) DECONTAMINATION OF EGCR CHARGE AND SERVICE MACHINES. A. B. Meservey, J. M. Chilton, and D. E. Ferguson (Oak Ridge National Lab., Tenn.). Oct. 13, 1960. 5p.

Methods for the noncorrosive removal of volatile fission

products and UO_2 dust from carbon steel and stainless steel were developed. Procedures for applying these methods to the decontamination of the EGCR charge and service machines are described. (auth)

13912 (CRRP-998) ANALOG SIMULATION OF XENON INSTABILITY. R. M. Pearce (Atomic Energy of Canada Ltd., Chalk River, Ont.). Jan. 20, 1961. 54p. (AECL-1185)

Spatial oscillations in the flux of a power reactor, caused by xenon and temperature effects, are studied on a general-purpose electrical analog computer. The linearized forms of the two-group diffusion equation are solved in one dimension using finite space intervals. The linearized forms of the iodine and xenon equations are solved using continuous integration. Good agreement is obtained with predictions from other theories in simple cases. In the case of a large uniform reactor with a threshold flux for oscillation well below 10^{13}, the oscillating portions of the fast and slow flux distributions and of the xenon and iodine distributions all have the same shape in space. For smaller reactors with thresholds above 10^{13}, the fluxes and iodines retain their space shape during a cycle when only the lowest mode is excited, but the oscillating part of the xenon changes shape during a cycle. This is a result of the xenon lifetime's varying through the reactor. At a central flux of 2.1×10^{14}, the maxima in the xenon occur 2.5 hr later at the outside of a cylinder than at the center. Some examples of mode shapes are given for reflected reactors. A two-group study of the first azimuthal mode of CANDU at three powers and several prompt power coefficients appears to indicate that the mode is damped. (auth)

13913 (CVNA-69) DEVELOPMENT OF THE CVTR PRESSURE TUBE HEADER ASSEMBLY. H. J. Cordle (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Sept. 30, 1960. 75p.

Based on the specific needs of the CVTR plant, a header assembly to distribute the pressurized heavy-water coolant to the pressure tubes was developed from a basic design chosen from several configurations. The design chosen is comprised of 84 2-in. feeder tubes (jumpers) manifold into four straight, horizontal, and parallel 8-in. headers which are located in pairs above and on either side of the reactor moderator tank. Design analysis included items such as heavy-water containment, pressure drop, stresses, fabrication, and maintenance requirements. (auth)

13914 (GA-1100(Suppl. 2)) MARITIME GAS-COOLED REACTOR PROGRAM. SAFEGUARDS REPORT FOR THE MGCR CRITICAL EXPERIMENT. A. D. McWhirter, S. H. Levine, and J. M. Stein (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Dec. 1, 1960. Contract AT(04-3)-187. 34p.

Plans for critical experiments in the development of a beryllium oxide-moderated reactor (BORE) are discussed. The purpose of BORE is to demonstrate the feasibility of this type reactor. The existing MGCR critical facility will be used to perform the BORE critical experiments. A hazards analysis for the BORE critical experiments is presented which offers evidence that performance of these experiments will create no undue risk to personnel. (J.R.D.)

13915 (GAMD-974) COMPARISON OF BeO VERSUS GRAPHITE AS A MODERATOR FOR MGCR. W. P. Wallace and M. T. Simnad (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 11, 1959. Contract AT (04-3)-187. 11p.

The comparison is made on the basis of nuclear requirements, properties, cost, and performance under irradiation. Results of published work were reviewed on the effects of irradiation on beryllium oxide and beryllium oxide–uranium dioxide dispersions. A research proposal for a Maritime Gas-cooled Reactor Moderator is included. (J.R.D.)

13916 (KAPL-2085) NUMERICAL SOLUTION OF THE DIFFUSION EQUATION IN TRIANGULAR AND HEXAGONAL GEOMETRIES. J. P. Jewett (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 15, 1960. Contract W-31-109-Eng-52. 31p.

The solution of the neutron-diffusion equation in two-dimensional triangular and hexagonal grids is discussed. Seven-point difference equations in a triangular mesh are derived, and various methods of solving the resulting system of equations are given. Included is an alternating direction-implicit method that was programmed for the IBM 704. The results of this method are compared with those obtained by using the FLEER code. A special code was also written to investigate the accuracy of the four-point difference equation. Results obtained with this code are presented. (auth)

13917 (NAA-SR-Memo-770) USE OF A WATER BOILER REACTOR AS A PRODUCTION TEST FACILITY. M. E. Remley (North American Aviation, Inc., Downey, Calif.). Aug. 25, 1953. Decl. Nov. 6, 1958. 11p.

The feasibility of the use of a water-boiler type reactor as a production test facility for making reactivity tests on various forms of uranium and uranium compounds was investigated. It is concluded that the reactor should be very useful for production testing of materials with the danger coefficient technique. A suggested production procedure is outlined. (auth)

13918 (NAA-SR-Memo-810) MEASUREMENTS AND ANALYSIS OF URANIUM-D_2O LATTICES. F. B. Estabrook and S. W. Kash (North American Aviation, Inc., Downey, Calif.). Nov. 16, 1953. Decl. Nov. 6, 1958. 28p.

A series of exponential measurements performed on uranium-heavy water lattices is summarized. Three enrichments of fuel materials were used: 0.49, 0.71 (natural), and 0.90 wt. % U^{235}. The uranium fuel slugs ranged from 0.75 to 2 in. in diameter and were encased in tubes of 0.40-in. aluminum. The lattice cell spacings varied from 3 to 12 in. The analysis of the data is divided into two parts. The first part deals directly with the neutron flux measurements and reports for each lattice, the material buckling (B^2), a pair of disadvantage factors (F and F_m), and a flux ratio (R). The second part of the analysis is concerned with the long-range problem of improving reactor calculations. Attempts were made to correlate the measurements with themselves and with other nuclear measurements so as to obtain a consistent formalism for computing uranium–heavy water reactor parameters. (W.L.H.)

13919 (NAA-SR-Memo-1200) COMPARISON OF POWER DENSITY AND THERMAL STRESS FOR ROD, TUBE, AND PLATE FUEL ELEMENTS. T. T. Shimazaki (North American Aviation, Inc., Downey, Calif.). Dec. 14, 1954. 10p.

A comparison is made of power density and thermal stress for rod, tube, and plate fuel elements. Assumptions made in the comparison are that heat generation in the fuel elements is uniform, the fuel elements are infinitely long, the physical properties of the fuel are uniform and constant, and all surfaces of the fuel elements are at the same temperature. (D.L.C.)

13920 (NAA-SR-Memo-1503) ORGANIC IN-PILE LOOP QUARTERLY PROGRESS REPORT PERIOD END-

ING SEPTEMBER 1955. R. H. J. Gercke and S. Nakazato (North American Aviation, Inc., Downey, Calif.). Nov. 2, 1955. 16p.

The organic in-pile loop experiment was successfully completed. The analyses of the neutron flux monitors will be completed soon. The preliminary results observed are reported. The irradiation of the diphenyl and ortho-terphenyl eutectic produced predictable amounts of decomposition products. The heat transfer surface was apparently not fouled when examined after conclusion of the experiment. The induced activity of the organic was less than expected. No shielding was required for the sampling operation. The induced activity was mainly chlorine and cobalt. It remained with the high-boiling residue following distillation. The melting point of the irradiated organic was less than that of the starting material. (auth)

13921 (NAA-SR-Memo-1956) SOME NUCLEAR EXPERIMENTS ON THE SRE. C. Guderjahn (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 5, 1957. 17p.

Subcritical assembly experiments were conducted by loading fuel elements in a SRE core and determining the critical mass from the counting rate data obtained from fission counters placed in the fuel channels. A plot of the normalized inverse count rate as a function of the number of the fuel elements loaded indicated a critical mass of 22.2 dry fuel elements at room temperature and 32.64 ± 0.10 fuel elements at 400°F using a sodium coolant. The reactivity of the subcritical SRE was estimated from subcritical multiplication measurements, and the results were used to evaluate the worth of various fuel elements and poison elements. The total reactivity change caused by replacing each uranium element with a thorium-5% uranium element was determined. Flux mapping studies were made of the dry subcritical SRE using cadmium-covered and bare gold foils in the core and reflector. The results of the flux measurements are given graphically. (B.O.G.)

13922 (NAA-SR-Memo-3320) A MODEL OF BUBBLE GROWTH IN THE KEWB REACTOR. D. P. Gamble (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 2, 1959. 80p.

Short-period transients (less than 15 msec) in the KEWB reactor are apparently controlled primarily by void production resulting from gas evolution in the core. A growth mechanism probably prevails during the short-period excursions which differs from that which occurs at longer periods. Experimental data were examined which showed that the energy transferred to the average bubble is an order of magnitude less than that required to cause bubble growth. It is believed, however, that the validity of the growth model can be established by refinements concerning energy availability deposited in the bubble area and by refinement of bubble-size distribution functions. (J.R.D.)

13923 (NAA-SR-Memo-5324) BRAKE-CLUTCH CONTROL ROD DEVELOPMENT. P. F. Shaw (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 25, 1960. 8p.

The design, development, and fabrication of a control rod assembly that has no mechanisms above the reactor face are described, and allows for combining shim, regulation, and safety operations in a single rod. Included are descriptions of prototype testing experience, recommended modifications, and operating behavior of the present model. (J.R.D.)

13924 (NAA-SR-Memo-5472) NaK PRECIPITATION INDICATOR TEST SYSTEM AND EXPERIMENTS TO DATE. G. M. Kikin (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 13, 1960. 37p.

A test loop was constructed and developed in which the solubility relations of potassium–sodium oxides and hydrides in potassium–sodium alloys at 1000°F were determined. Other tests conducted in the loop included those for evaluation of the SER and HNPF precipitation indicator capabilities to determine the precipitation temperatures of the eutectic hydride and oxide as functions of hydride and oxide concentrations. Plugging in the potassium–sodium system was also investigated. (J.R.D.)

13925 (NAA-SR-Memo-5623) PRELIMINARY ANALYSIS OF THE THERMAL PERFORMANCE OF AN APM-UO_2 FUEL ELEMENT AFTER A LOSS OF FLOW ACCIDENT. J. R. Laccabue and E. A. Licitra (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 22, 1960. 15p.

Tests were conducted to evaluate the maximum temperature of an APM-UO_2 fuel-element cladding surface after a loss-of-flow accident. During steady-state operation, the expected maximum cladding surface temperature is 800°F. Maximum surface temperatures were determined by analog simulation and are tabulated along with parameters used for the study. (J.R.D.)

13926 (NDA-2132-4) A STUDY OF WET STEAM AS A REACTOR COOLANT. TECHNICAL PROGRESS REPORT FOR THE PERIOD APRIL 1, 1960 THROUGH DECEMBER 31, 1960. G. Sofer, H. Firstenberg, and S. Hurwitz (Nuclear Development Corp. of America, White Plains, N. Y.). Jan. 31, 1961. Contract AT(30-1)-2303. Project VII. 32p.

Research and development investigations of water-steam mixtures under dispersed flow conditions (fog) and their applications to light-water-moderated nuclear power reactors are reported. The advantages of fog coolant are listed. Burn-out, heat transfer, and pressure drop data were obtained under fog-flow conditions at CISE. Localized flow measurements in the CISE test loop indicated that the slip ratio in the bulk of the flow stream is near unity. Corrosion tests in the loop indicated the absence of erosion effects in Zircaloy and stainless-steel specimens. Low-temperature fog mixing tests indicated that the most effective mixer design is obtainable in a peripheral water injection arrangement. A theoretical investigation was made of burn-out heat transfer under fog flow conditions using a model based on eddy diffusion of droplets from the bulk of the flow stream to the heated wall. Nuclear calculation methods were developed and coded for Datatron computation to prevent more accurate calculation of reactivity effects. A conceptual reactor design, using fog as the coolant in a light-water-moderated reactor, is being developed. (M.C.G.)

13927 (NYO-9070) PEBBLE BED REACTOR PROGRAM. PBM—A TWO-GROUP TWO-REGION REACTOR MODEL FOR HOMOGENEOUS, HIGHLY ABSORBING SYSTEMS AND MACHINE CODES FOR ITS APPLICATION. (Sanderson and Porter, New York). Dec. 1960. Contract AT(30-1)-2207. 68p.

A nuclear model was developed for homogeneous two-region reactors possessing a relatively large percentage of epithermal absorptions in both the core and blanket region. A number of new IBM 650 programs were developed, and existing programs modified to form a group of programs, compatible with the nuclear model and with each other, which can be used for preliminary evaluation of the effect of design variables on reactor characteristics. Theoretical aspects of the model and machine programs are de-

scribed. A fully executed example problem is presented. A comparison is made between calculated and experimental results, which shows large discrepancies for small fast cores and progressively smaller discrepancies as the cores become more thermal. (auth)

13928 (RM-2693(RAND)) NEUTRON BRANCHING PROCESSES. T. W. Millikin (RAND Corp., Santa Monica, Calif.). Jan. 4, 1961. 32p. Contract AF(490638)-700.

Neutron population in a nuclear reactor is studied as a branching process. New results on the extinction probability of a supercritical reactor near the critical dimension are presented as an extension of T. E. Harris' results. Parts of the theory of branching processes also are presented. The results apply to spheres, infinite slabs, and rods with the assumptions of constant neutron energy and isotropic collision-fission processes. The assumption of homogeneity is made, although similar results can be obtained in non-homogeneous cases of restricted types. A new computational method is developed for estimating the critical dimension and the steady-state flux for supercritical reactors; this method replaces the eigenvalue problem of transport theory by a nonlinear functional equation solvable by iteration. (auth)

13929 (RPI-76(AECL)) BUCKLING MEASUREMENTS FOR 7-ELEMENT UO_2 CLUSTERS IN ZEEP. G. A. Beer and R. E. Green (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Jan. 1961. 45p. (AECL-1191)

Buckling measurements were made in ZEEP for a hexagonal lattice of 55 seven-element UO_2 clusters spaced at 24.56 cm. Measurements were made with different moderator purities, and the effect of removing the coolant from the clusters was also measured. The results are in good agreement with lattice calculations. (auth)

13930 (TID-5840) ATOMIC ENERGY COMMISSION—BUREAU OF MINES PROCESS HEAT REACTOR PROGRAM. Quarterly Progress Report, February 1 to April 30, 1959. L. L. Hirst, J. P. McGee, and G. R. Strimbeck (Bureau of Mines. Appalachian Experiment Station, Morgantown, W. Va.). 28p.

Research for the Process Heat Reactor conducted on high-temperature induction-heated recirculation loops is reported. A 23-day run was completed in the 250-psig pressure loop. The temperature of the exit helium from the simulated-nuclear reactor was slowly increased as the run progressed, reaching a maximum of approximately 2050°F. The run was terminated when the impeller of the helium recycle compressor rubbed against the housing. Studies indicated that creep of the stainless-steel rotor reduced the clearance between the rotor and the housing. A redesigned helium purification train was installed, including a Freon refrigeration system to condense out water vapor. A Wolfram tester to detect total reacting impurities in helium is being developed. A helium-heated coal gasifier was developed. An electrostatic precipitator designed to operate at 300 psig and 1000°F was constructed. A study was made of the cost of producing hydrogen from methane in a nuclear process heat reactor. (M.C.G.)

13931 (TID-6946) PROCESS HEAT REACTOR PROGRAM. Quarterly Progress Report for period August 1–October 31, 1960. N. H. Coates, R. F. Stewart, W. T. Abel, J. P. McGee, and L. L. Hirst (Bureau of Mines. Morgantown Coal Research Center, W. Va.). 17p.

Preliminary tests with the Induction-heated Simulated-Nuclear Reactor revealed that tubes of kt silicon carbide, silicon carbide foam, and normal silicon carbide are not suitable for use in the Process Heat Reactor. To prevent the siliceous deposits formed, the sphere container was constructed of a Zirconia tube lined with porous carbon. After 1000 hr, leakage from the helium recycle loop was only 3 to 4 std. c.f.h. A laboratory-scale loop was constructed to study the characteristics of a helium–graphite suspension recycle system. A single spiral coil of stainless-steel tubing was tested to determine its ability to withstand continuous operation in the Process Heat Reactor system at 1700°F. A lignite slurry was pumped through the coil for 114 hr before the coil plugged. Subsequent examination failed to reveal the cause of plugging. A helium-heated coal gasifier was developed to demonstrate the feasibility of gasifying steam-coal mixtures with heat transferred from hot recycled helium. Dust was removed from gases at elevated temperatures and pressures with an electrostatic precipitator. Removal efficiencies exceeded 99% for all tests at 5 to 80 psig and 1200°F. (M.C.G.)

13932 (TID-11109) HYDRAULIC CONTROL ROD DRIVE MECHANISM FEASIBILITY STUDY. Second Quarterly Report for the Period Ending October 31, 1960. R. B. Hussey and C. F. Cartledge (American Bosch Arma Corp. American Bosch Div., Springfield, Mass.). Nov. 8, 1960. Contract AT(30-1)-2529. 48p.

The digital readout concept for rod position was completed, the snubber design was established, and the Aurora pump was tested and found to be satisfactory. Preliminary tests on the flow model revealed binding of the piston and piston rod. It was found to be mechanical in nature and was eliminated by providing a swivel connection between the piston rod and the weight. Tests showed unbalanced pressures in the leakage paths of the control sleeves causing binding of the sleeves. Providing two sets of control porting, located diametrically opposite to each other, did not reduce the binding in the control sleeves to a satisfactory value. The control sleeves were replaced and tests with the new sleeves showed no improvement in the binding condition. A new piston configuration was established which reduces leakage and provides a strengthened snubbing section. Flow model leakage tests were run using the new control sleeves. (auth)

13933 (TID-11439) CHEMISTRY OF FUEL ELEMENT CATHODE MATERIALS. Melvin G. Bowman (Los Alamos Scientific Lab., N. Mex.). [1960?]. 11p.

The thermodynamic properties and phase relationships, which characterize the composition and behavior of materials at high temperatures, must be known before an optimum selection can be made between different fuel-element cathode materials. Some fundamental properties of UC, ZrC, and ZrC–UC are described and related to the practical problems of: (1) the useful lifetime of cathodes with respect to vaporization losses, (2) the compatibility of cathode materials with supporting conductors, and (3) methods of bonding fuel-element materials to support materials. (auth)

13934 (VDIT-28) TUBE AND FUEL ELEMENT RUPTURE. A Bibliography of Selected Literature. Ernst Bock (Aktiebolaget Atomenergi, Stockholm). [1960]. 7p.

A total of 28 references, some with appended abstracts, is given on the subject of fuel-element and tube rupture testing. (D.L.C.)

13935 (WAPD-BT-21) BETTIS TECHNICAL REVIEW. REACTOR TECHNOLOGY. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Nov. 1960. Contract AT(11-1)-GEN-14 and appropriate NObs-Contracts. 101p.

Eight papers are presented. Separate abstracts were prepared for each paper. (J.R.D.)

13936 (WAPD-BT-21(p.29-32)) REPRESENTATION OF TWO-DIMENSIONAL SELF-SHIELDED POISON CALCULATIONS. LUMPS IN P-1. N. G. Demas (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

A method is described for obtaining effective thermal constants for an explicit poison lump region of a two-dimensional diffusion theory calculation (PDQ or TURBO). The method is illustrated for a particular lump geometry and mesh description, and the effective constants obtained are used in several test geometries. The relative capture rate of the poison lump, $\int_{\text{lump}} \Sigma_a \varphi / \int_{\text{fuel}} \Sigma_a \varphi'$ in these examples, as calculated from one-group PDQ problems using these "NGD blackness" effective thermal constants, is plotted as a function of the physical Σ in the poison lump. The relative capture rates obtained from comparable calculations using TUT and PDQ calculations using one-dimensional blackness theory in the lump are plotted for comparison. (auth)

13937 (WAPD-BT-21(p.69-77)) SHIPPINGPORT REACTOR PROTECTION SYSTEM EXPERIENCE. A. I. Moss (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh).

The results of two years of operating experience of the Shippingport Reactor Protection System are presented, and the performance of the key system components, principally magnetic amplifiers, is discussed. Experiences encountered in system testing at full-power conditions, time-response measurements, set-point determinations, and pump switching operations are detailed, and areas in which improved reliability was achieved are described. An accounting of the reactor protection shutdowns during the 2-yr period presents an indication of the reliability that may be expected with the first-generation nuclear-powered central stations. (auth)

13938 (WAPD-R(J)-39) SASS-1—SUBASSEMBLY STRESS SURVEY CODE. Carl M. Friedrich (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1960. Contract AT-11-1-GEN-14. 18p.

SASS-1, an IBM-704 FORTRAN code, calculates pressure, thermal, and combined stresses in a nuclear reactor core subassembly. In addition to cross-section stresses, the code calculates axial shear stresses needed to keep plane cross sections plane under axial variations of temperature. The input and output nomenclature, arrangement, and formats are described. (B.O.G.)

13939 (WCAP-1735) THERMOELECTRIC NUCLEAR FUEL ELEMENT MONTHLY PROGRESS REPORT NO. 32 COVERING THE PERIOD FEBRUARY 1961. G. R. Kilp, W. P. Blankenship, K. J. Gill, R. C. Goodspeed, P. V. Mitchell, and E. G. Schwartz (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Mar. 10, 1961. Contract AT(30-3)-500. 13p.

New procedures resulted in successful preparation of US_2, U_2S_3, and U_2Se_3. A swaged $USe_{1.6}$ element is being instrumented for test. A new welding chamber was acquired to ease fabrication problems. Two new PbTe elements were put on test. A PbTe and a USe element were returned to the test line. A swaged PbTe element was inserted into WTR. Two new in-pile capsules are being fabricated. Six elements were fabricated and several more brought to various stages of fabrication, using AlSiMag insulation. Component fabrication techniques were improved such that a twenty-couple element only 3 in. long was assembled. Early results indicated short-time compatibility of AlSiMag insulation and PbTe. The life test of a hot-swaged PbTe element continued at 5100 hr. A 500 kw(e) thermoelectric reactor design is essentially complete. (auth)

13940 (UCRL-Trans-650(L)) DETERMINATION OF CRITICAL MASS AND NEUTRON FLUX DISTRIBUTION BY THE METHOD OF PHYSICAL MODELS. V. A. Dmitrievskii and I. S. Grigorev. Translated from Kernenergie, 3: 366-70(1960). 16p. (includes original, 5p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 16417.

13941 INVESTIGATION OF THE SR-1 HETEROGENEOUS SUBCRITICAL ASSEMBLY. L. Pal, F. Szabo, Z. Gyimesi, L. Bata, and L. Turi. Acta Phys. Acad. Sci. Hung., 12: 205-19(1960). (In Hungarian)

The results of experiments carried out on the SR-1 heterogeneous subcritical assembly consisting of cylindrical fuel elements (enriched in U^{235} to 10%) and distilled water are reported. The critical mass and the effect of local distortions in the core on criticality are determined. The distributions of thermal as well as resonance neutrons in the core, in the reflector, and between two adjacent fuel elements are measured. The asymptotical distribution of the thermal neutrons in the reflector is studied. (auth)

13942 SOME INFORMATION ON HEAVY WATER INSTALLATIONS. Y. La Prairie. Energie nucleaire, 2: No. 2, 117-19(Mar.-Apr. 1960). (CEA-1628). (In French)

Since national production of heavy water is beginning in France, it is of interest to outline the French program with regard to heavy-water-moderated reactors and particularly to situate this program with respect to foreign research or construction. The CEA possesses four heavy-water research reactors: EL1 (Zoé), EL2, EL3, and Aquilon. This represents an immobilization of about 40 tons of this moderator. No new heavy-water research-reactor project is at present on the French program; however, a prototype power center with heavy-water moderation, EL4, is one of its major items. (auth)

13943 RULES FOR NUCLEAR SHIPS. Engineer, 211: 329-33(Mar. 3, 1961).

"Lloyds' Register of Shipping Rules for Nuclear Ships" is summarized. Requirements for the hull, reactor and main machinery, containment, reactor core and fuel assemblies, pressure vessel and primary circuit materials, decay heat removal, reactor control and instrumentation, electrical installation, shielding, (defueling), effluent disposal, and maintenance are discussed. (M.C.G.)

13944 CONTROL OF RADIOACTIVITY IN THE ENVIRONS OF THE WÜRENLINGEN REACTOR. E. Nagel (Institut Federal de Recherches en Matiere de Reacteurs, Würenlingen, Switzerland). Neue Tech., 2: No. 12, 37-40 (1960). (In French)

The principles for the survey of radioactivity in the environment of the reactor site at Würenlingen are stated. The survey of air, rain and river water, foodstuffs grown in the area, and the general irradiation damage produced by γ rays is discussed. Furthermore, some methods for sampling and analysing samples and for a quick detection of possible contaminations are described. (auth)

13945 THE PHOTONEUTRON SOURCE FOR START-UP PROCESS FOR THE WWR-S REACTOR. Krzysztof Zarnowiecki and Przemyslaw Szulc (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 705-11(1960). (In Polish)

A photoneutron source with a yield of 10^7 to 10^8 neutrons sec was designed and constructed. Beryllium is irradiated

by γ radiation of fission products included in the reactor fuel elements and the (γ,n) reaction takes place. To the beryllium some antimony, which serves as an additional γ radiation source, was added. It diminished the yield changes of the neutron source with time. (auth)

13946 THE ERROR ESTIMATION OF LINEARIZED NUCLEAR REACTOR EQUATIONS. Karol Wajs (Electro-Technical Inst., Warsaw). Nukleonika, 5: 738-42(1960). (In Polish)

The error of nuclear reactors kinetic equations, treated as a linearized control system component, was estimated based on the theory of differential inequations. The influence of delayed neutrons was taken into account. (auth)

13947 THERMAL UTILIZATION FACTOR IN WATER-GRAPHITE MODERATED LATTICE. Antoni Kuszell and Janusz Mika. Nukleonika, 5: 744-54(1960). (In English)

One- and two-group calculation methods of the thermal utilization factor in a heterogeneous reactor with two moderators are discussed and compared. The modification of the standard two-group method, based on the assumption of non-zero neutron current at the boundary of the cell, is given. (auth)

13948 SOME PROBLEMS OF THE ACTIVATION DURING PERIODICAL OPERATION OF THE REACTOR. Andrzej Kowalew (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 755-9(1960). (In Polish)

A basic problem in the production of radioisotopes consists in the calculation of an activation time, which is needed for an a priori assumed activity in the target material. Self-screening, the absence of the continuity of the reactor operation, and other factors make the calculation of the activation time very difficult as well as time consuming. The calculation difficulties connected with the noncontinuity of the reactor operation can be avoided if the reactor operates periodically. By this assumption the relationship between the activation time and the activity to be obtained is simplified. On the basis of this relation an evaluation can be made how the efficiency of the activity, lowered by the periodical operation of reactor, could be compensated by a prolonged time of activation. (auth)

13949 DEFINITION AND CALCULATION METHODS OF THE AMPLIFICATION FACTOR OF NEUTRON AMPLIFIERS. G. Fodor (Polytechnical Univ., Budapest). Periodica Polytech. (Elec. Eng.), 4: 205-25(1960). (In English)

As subcritical multiplier systems, the neutron amplifiers can be used for various purposes, and accordingly the amplification factor can be defined in various practical ways. The most characteristic is the amplification factor which is defined as the ratio of the number of thermal neutrons absorbed in the unit of time, or the number of fast neutrons released in the unit of time on one hand and of neutron source intensity on the other hand. The expression for the amplification factor depends, to a small extent, on applied calculation method. If the amplifier is, however, in a near-critical condition, deviations can be neglected. Basically, only such systems can be compared which are equally far from the critical condition. The critical condition, however, is difficult to be characterized by a single value. In these considerations, a simple and well characterizing value is the degree of criticality (s^3), the quotient of actual fissionable material quantity and of the critical fissionable material quantity. In the case of a given material composition this is equal to the quotient of the actual and of the critical volume of the active zone. A value which is characterizing only to a lesser extent is the negative reactivity, which depends, beyond the degree of criticality, on material composition too. In the case of a given degree of criticality (or of negative reactivity) an amplification factor can be produced by different systems. Of all the possible solutions, the one that cost the least is regarded as optimum. Costs are determined by the fuel and, in case of heavy water, by the moderator. On designing for a given number of neutrons, costs of the source should also be taken into account. It is shown that in a near critical system flux distributions obtained by different approximate calculation methods only vary to a small extent. (auth)

13950 THE CHARACTERISTICS OF HOMOGENEOUS NEUTRON AMPLIFIERS. G. Fodor (Polytechnical Univ., Budapest). Periodica Polytech. (Elec. Eng.), 4: 305-25 (1960). (In English)

The data and characteristics of various simple homogeneous neutron amplifiers were calculated. The amplification factor was determined as a function of cost. For every arrangement there was a dilution value ensuring minimum costs. From certain points of view this could be regarded as an optimum condition. The amplification factor can be increased by suitably chosen geometry and by using more-stage systems. Minimum costs rise in respect to the spherical or cylindrical arrangement, consequently the use of these methods is generally not practical. (auth)

13951 PLAN FOR MAINTENANCE OF INSULATION ON CONTAINMENT STRUCTURES. H. H. Norden (Knolls Atomic Power Lab., Schenectady, N. Y.). Power Eng., 65: No. 2, 37-8(Feb. 1961).

The problem of maintaining the insulation on containment structures for nuclear reactors is considered. Several reactors with spherical and cylindrical containment structures are enumerated, and the insulation of the AEC sphere at West Milton, N. Y., is described in detail. A sampling technique is proposed to establish the condition of the insulation for possible repair. The size and condition of the population are considered, i.e., the degree of homogeneity of the insulation exposure to the elements. For analysis accuracy, both Cochran and Stein methods are presented for calculating the required sample size. (D.L.C.)

13952 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Commissariat à L'Énergie Atomique). British Patent 861,513. Feb. 22, 1961.

A pressure vessel is designed which is to be made out of concrete and to be used as a biological shield as well as a reactor pressure vessel. The vessel is subjected to centripetal forces in excess of the forces produced by the coolant pressure by means of metal cables distributed in and about the vessel. Several possible vessel shapes are given. (D.L.C.)

13953 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL COMPOSITIONS. Ronald George Tongue. (to United Kingdom Atomic Energy Authority). British Patent 861,602. Feb. 22, 1961.

The properties of fissile-material suspensions in liquids can be improved by forming the particles with a core of fissile material and a surface layer of fertile or neutron-moderating material. Some of the improvements that may be obtained in this way are elimination of the tendency of the suspension to settle, increased heat transfer, and retainment of the fission products in the particles. Some possible forms of suspensions are given. (D.L.C.)

13954 METHOD OF COOLING A NUCLEAR REACTOR. (to U. S. Atomic Energy Commission). British Patent 862,587. Mar. 15, 1961.

A mixture for use as a reactor coolant which avoids the disadvantages of water and liquid metals is one consisting of at least one polyphenyl compound having 2 or 3 phenyl rings per molecule and at least one polynuclear aromatic compound having not more than 4 aromatic rings per molecule. The polyphenyl compound increases the radiation resistance of the mixture by an amount more than that expected from the proportions of the components. Other advantages of the mixture are the lack of corrosive effects on reactor materials, high thermal conductivity and heat capacity, and good viscosity and low vapor pressure at the operating temperatures (≥400°C). The mixture should have at least 20% of the polyphenyl compound, and eutectic mixtures with low melting points are especially preferred, e.g., 50% biphenyl–50% m-terphenyl. Where the temperatures are not excessive, as in secondary coolants, and the induced radioactivity in the coolant is not critical, various additives may be incorporated in the mixtures. Such additives are inhibitors of free radical reactions (iodo-substituted aromatic compounds), antioxidants (aromatic selenides and sulfides), and inhibitors which form stable free radicals (phthalocyanine and triphenylmethane). Results are reported for irradiation tests of various mixtures. (D.L.C.)

13955 IMPROVEMENTS RELATING TO FUEL ELEMENT CANS FOR NUCLEAR REACTORS. Dermot Frederick Hughes (to English Electric Co. Ltd.). British Patent 862,609. Mar. 15, 1961.

A fuel element can is designed with an extended heat transfer surface in the form of lengthwise extending webs spaced angularly around the can and joined together by transverse webs spaced at intervals along the can length. The webs may be formed by machining a series of depressions in a thick-walled can or by a casting process. The webs may also be made helical. (D.L.C.)

13956 IMPROVEMENTS RELATING TO NUCLEAR REACTORS AND FUEL ELEMENTS THEREFOR. George Erasmus Darwin and Norman George Worley (to Babcock & Wilcox Ltd.). British Patent 862,623. Mar. 15, 1961.

A fuel element for gas-cooled, graphite-moderated reactors is designed with improved supporting means for withdrawal from the core. The element has an elongated can provided with circumferentially spaced and longitudinally extending external fins which serve as can-supporting means. At one end of the can, coupling means are provided to engage with the grab of a fueling machine, while at the other end, support means are provided to engage the adjacent end of the can. (D.L.C.)

13957 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR INSTALLATIONS. Sydney Fawcett and Peter Waine (to United Kingdom Atomic Energy Authority). British Patent 862,624. Mar. 15, 1961.

A reactor containment scheme is outlined for gas-cooled reactors in which the gas is circulated in a closed circuit from the core to heat exchangers. In this scheme, the reactor pressure vessel, coolant ducts, and heat exchangers but not the fueling machine are contained within an inner housing which is sealed to withstand a pressure surge resulting from a breach in the coolant circuit. An outer housing is provided for the reactor installation, and gas treatment means (heat sink and absorption tower) are positioned outside the outer housing. On a breach occurring in the primary coolant circuit, the resulting pressure surge forces gas into the heat sink and thence to the absorption tower; if the activity of the air enclosed between the outside and inside housings becomes too high, it is also passed into the heat sink. The scheme permits the maintenance of an inert atmosphere such as nitrogen or CO_2 around the breached primary coolant circuit, preventing oxygen–moderator reactions. (D.L.C.)

13958 REACTOR. S. K. Allison. U. S. Patent 2,975,114. Mar. 14, 1961.

A nuclear reactor is described in which unjacketed fuel extends through moderator in direct engagement therewith and is cooled by fluid that flows through passages in the moderator parallel to and spaced from the fuel so as to be kept out of contact therewith. The fluid passages are arcuate when considered transversely of their lengths so as collectively to surround the fuel like an imaginary interrupted ring.

13959 BELLOWS SEAL ON REACTOR COOLANT TUBE. E. P. Wigner, L. A. Ohlinger, and G. J. Young. U. S. Patent 2,975,115. Mar. 14, 1961.

A seal is described for use between the gas shell or container of a reactor and the coolant tubes which extend through the shell or container so that not only is effective sealing provided but also provision is made for thermal elongation and contraction of the tubes, removal of the tubes, and effective replacement of damaged or corroded tubes.

13960 NEUTRONIC REACTOR. F. Daniels. U. S. Patent 2,975,116. Mar. 14, 1961.

A neutronic reactor is described which is comprised of a central reactive mixture of pellets of enriched uranium oxide and beryllium oxide, a layer of beryllium oxide pellets surrounding the central mixture, a layer of thorium oxide pellets surrounding the first layer, and a coolant in the voids between the pellets.

13961 FAST NEUTRON REACTION SYSTEM. W. H. Zinn. U. S. Patent 2,975,117. Mar. 14, 1961.

A nuclear reactor is described in which nuclear fission is caused by high-energy neutrons. There is a central reactive zone containing closely spaced vertical rods of high fissionable material content. Surrounding this zone is a first reflector zone made up of vertical rods of uranium of normal isotopic content. A second reflector zone contains natural uranium in wedge-shaped blocks laid around the first reflector zone to form a hollow cylinder. This second zone has one or more movable doors that can be opened varying amounts to control the reactor by varying neutron leakage. The whole second reflector may be dropped from position for emergency control. The second reflector zone is enclosed in a graphite moderator-reflector to return thermal neutrons to the reflectors for plutonium conversion.

13962 VERTICAL ROD DRIVE MECHANISM. C. D. Emmons. U. S. Patent 2,975,119. Mar. 14, 1961.

A device is described for supplying air between the upper end of a cylinder and a piston therein attached to a vertical safety rod for a nuclear reactor. The fall of the safety rod into the reactor is cushioned by air trapped between the piston and the lower end of the cylinder. At the upper end of the cylinder air under pressure is supplied against the piston to separate the piston from an electromagnet at the top of the cylinder and thus to speed the fall of the safety rod. When the safety rod is lifted out of the reactor, banging of the piston against the upper end of the cylinder is prevented by air trapped above the piston.

13963 NEUTRONIC REACTOR. J. A. Wheeler. U. S. Patent 2,976,227. Mar. 21, 1961.

A neutronic reactor is described which is comprised of slabs of uranium and a solid moderator and means for adjusting the relative position of at least one moderator slab

to vary the moderator-to-fuel ratio in the reactor, thereby controlling the reactor.

13964 REACTOR FUEL ASSEMBLY. E. A. Evans, R. J. Anicetti, and W. E. Roake. U. S. Patent 2,977,297. Mar. 28, 1961.

A vertical nuclear fuel assembly is described which is comprised of a central fuel rod and two inner and outer fuel tubes surrounding the fuel rod in concentric, radially spaced relationship to the fuel rod, the outer fuel tube being radially spaced from the inner fuel tube. The inner fuel tube is supported at its upper end through a connection with a perforated tube. The fuel rod and outer fuel tube are supported through connections between their lower ends and the lower end of the inner fuel tube. These connections permit the fuel rod and tubes to expand axially at different rates without undue mechanical stresses.

13965 NEUTRONIC REACTOR. Herbert E. Metcalf and Henry W. Johnson (to U. S. Atomic Energy Commission). U. S. Patent 2,978,398. Apr. 4, 1961.

A nuclear reactor incorporating fuel rods passing through a moderator and including tubes of a material of higher thermal conductivity than the fuel in contact with the fuel is described. The tubes extend beyond the active portion of the reactor into contact with a fluid coolant.

Power Reactors

13966 (ACNP-6104) PATHFINDER ATOMIC POWER PLANT. HYDRAULIC ANALYSIS OF PATHFINDER BOILER. Summary Report. N. C. Sher (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Feb. 15, 1961. Contract AT(11-1)-589. 28p. For Northern States Power Co. and Central Utilities Atomic Power Associates.

A hydraulic analysis of the Pathfinder boiler core was completed. A description of flow paths including a schematic diagram is included. Pressure drops along primary and leakage flow paths were calculated. After the resistance of each of the leakage paths was identified and the available driving forces in terms of pressure drops associated with the active flow were established, the leakage rates were easily determined. The dependence of pressure drops on core operating parameters was investigated. The boiler flow rates were also determined. The natural circulation flow rate as a function of power level was estimated at normal conditions of temperature and pressure. The relationships between the boiler parameters of flow, power, pressure, and inlet subcooling which arise through the laws of conservation of mass and energy are presented. (M.C.G.)

13967 (AGN-TM-361) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. EVALUATION OF NICKEL-BASED ALLOYS. Period Covered November 1958—November 1959. J. S. Brunhouse and G. W. Titus (Aerojet-General Nucleonics, San Ramon, Calif.). Jan. 1961. 63p.

An evaluation program was undertaken to determine which of several nickel-based alloys was best for cladding the individual fuel pins comprising the fuel elements for two reactor cores: the second core of the Gas-cooled Reactor Experiment, operating at NRTS, and the first core of the ML-1, the prototype of a mobile low-power nuclear power plant. Six alloys (chosen from a wide range of commercially available, nickel-based alloys) were subjected to extensive screening: Inconel, Inconel-X, Inconel 702, Hastelloy X, Hastelloy R-235, and Inor 8. Tests performed on these alloys included: gas corrosion tests for periods up to 5000 hr, in a 200-psi atmosphere of 99.5 vol.% nitrogen + 0.5 vol.% oxygen; air corrosion tests for 2500 hr at 300 psi; short-time room-temperature tensile tests; and short-time creep-rupture tests at various stresses. In addition to these thorough evaluations, the program also included more cursory examinations of several alternate alloys. Tests showed Hastelloy X to have the best combination of strength and corrosion resistance under the anticipated reactor operating conditions. Consequently, this alloy was selected as the cladding material for the fuel pins. (auth)

13968 (ANL-6255) GAS-COOLED REACTORS IN THE USA: A SURVEY AND RECOMMENDATION. R. H. Armstrong (Argonne National Lab., Ill.). Nov. 1960. Contract W-31-109-eng-38. 53p.

A study was made of approximately 132 reports on gas-cooled reactors and related subjects. Charts and tables containing the following information are included: all available reactor information, reactor flow diagrams of suggested concepts, possible core arrangement at core cross section, typical fuel and moderator cell, possible fuel types for unit fuel cell, the properties of materials for moderators and reflectors, the compatibility of gases and base fuel materials at maximum surface temperatures, maximum interface temperatures of fuel elements and core-jacket combinations, allowable operating temperatures and compatibility of gases and various metals, preferences for gas coolants, cost and availability of gases, plant thermal cycle efficiencies, thermal properties of gases, pumping power and reactor coolant inlet temperatures, obtainable heat fluxes, composition and physical properties of potential cladding materials, atomic and thermal properties of cladding materials, fabrication characteristics and costs of cladding materials, possible process applications of gases at high temperature, and potential high-temperature materials. The various categories of gas-cooled reactors and examples of each type are discussed. A gas reactor program for high-temperature experimentation is proposed. (M.C.G.)

13969 (ANL-6261) A LUNAR POWER PLANT. R. H. Armstrong, J. C. Carter, H. H. Hummel, M. J. Janicke, and J. F. Marchaterre (Argonne National Lab., Ill.). Dec. 1960. Contract W-31-109-eng-38. 137p.

A concept of a nuclear power plant to be assembled on earth and operated on the moon is presented. The two principal design objectives are reliability and high specific power. Wherever there is an incompatibility between these two objectives, the decision favors reliability. The design is based on the premise that the power plant must be designed on the basis of current technology and with a minimum amount of research and development. The principal components consist of a fast reactor in a direct cycle with a mercury-vapor turbine. The high-frequency generator, hydrogen compressor for the generator cooling system, mercury-recirculating pump, and condensate pump are on an extension of the turbine shaft. The mercury vapor is condensed and the hydrogen cooled in wing radiators. The reactor is of a construction quite similar to EBR-I Mark II for which there is a large amount of operating experience. The radiator is a vertical tube-and-fin type built in concentric cylindrical sections of increasing diameter. The curved headers are connected by swivel joints so that, upon arrival, the radiator can be quickly unfolded from the compact cylindrical package it formed during transportation. (auth)

13970 (ATL-505A) EVALUATION OF MERCURY COOLED BREEDER REACTORS. Donald W. Battles (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Dec. 14, 1960. 22p.

A technical and economic evaluation of a mercury-cooled fast breeder reactor is presented. The objectives of the program were to establish the technical feasibility of a fast breeder reactor cooled with boiling mercury and to evaluate the long-range potential of such a reactor power plant for production of economic power. Details of the conceptual design of a 100-Mw(e) reactor and system are discussed. The power cost from a mercury cooled fast breeder reactor was estimated as 21.4 mills/kwh which is competitive with the power cost for the initial Enrico Fermi plant. It was concluded that this reactor concept is technically feasible and has promising long-range economic potential. (M.C.G.)

13971 (BAW-1203(Vol.I)) NUCLEAR MERCHANT SHIP REACTOR PROJECT. EXTENDED ZERO POWER TESTS NS SAVANNAH CORE I. Final Report. A. L. MacKinney, R. M. Ball, C. E. Barksdale, M. L. Batch, J. W. Cure, J. P. Farrar, R. N. Kubik, R. H. Lewis, J. H. Mortenson, T. G. Pitts, S. W. Spetz, and H. J. Worsham (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Jan. 1961. Contract AT(30-1)-2534. 181p.

Experiments were performed on the NS Savannah Service Core I to supply information on future shipboard operation of the Nuclear Merchant Ship Reactor. Testing of instrumentation equipment was satisfactory. Correction factors for shipboard use were determined. Fast neutron flux, neutron flux distribution, and stuck control rod studies were carried out successfully, as was a three-dimensional calculation to match two critical rod patterns. (auth)

13972 (BAW-1217) REACTOR DECONTAMINATION. A LITERATURE REVIEW WITH RECOMMENDATIONS FOR DECONTAMINATION OF THE N. S. SAVANNAH REACTOR. F. W. Davis (Babcock and Wilcox Co. Atomic Energy Div., [Lynchburg, Va.]). Dec. 1960. Contract AT(30-3)-274. 69p.

A literature review was made of chemical decontamination methods, taking into consideration the materials of construction used in the Nuclear Merchant Ship Reactor Plant. Recommendations are given for chemicals and procedures to be used in the decontamination of the reactor primary system. 84 references. (B.O.G.)

13973 (DLCS-3070201) REACTOR PLANT SELF-ACTUATED RELIEF VALVE OPERATION. CORE 1, SEED 1. Test Results T-643700. (Duquesne Light Co., Shippingport, Penna.). First issue Oct. 11, 1960. 10p.

The relief valves that were tested included four each in the reactor coolant loop and in the purification system. Test results are tabulated which indicated that all valves operated at or within the prescribed limits of 2530 ± 50 psig in the "as left" condition. Most of the valves had to be popped and adjusted several times before the valves would pop at a pressure within the prescribed limitations. Some of the difficulties encountered during the testing are discussed. (B.O.G.)

13974 (DP-520) HEAVY-WATER-MODERATED POWER REACTORS ENGINEERING AND ECONOMIC EVALUATIONS. VOLUME II. ENGINEERING STUDIES AND TECHNICAL DATA. (Du Pont de Nemours (E. I.) & Co. Engineering Dept., Wilmington, Del.). Dec. 1960. Contract AT(07-2)-1. 198p.

The results of preliminary design and evaluation studies of various concepts of a power reactor that is moderated by heavy water and fueled with natural uranium are presented. Twenty-nine conceptual designs were developed for reactors ranging in capacity from 100 Mwe to 460 Mwe. Designs were prepared for hot- and cold-moderator reactors of the pressure vessel type, with liquid D_2O, boiling D_2O, D_2O steam, and helium as coolants. Also studied were cold-moderator pressure tube reactors cooled with liquid D_2O and boiling D_2O. The report includes the results of engineering studies of the reactor systems, electrical generation facilities, and auxiliary equipment. (auth)

13975 (DP-575) HEAVY WATER MODERATED POWER REACTORS PROGRESS REPORT, DECEMBER 1960. R. R. Hood and L. Isakoff, comps. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Mar. 1961. Contract AT(07-2)-1. 35p.

Construction of the Heavy Water Components Test Reactor (HWCTR) is 47% complete. The forecast start-up date is November 1961. Fabrication of two Zircaloy pressure tubes for the HWCTR bayonets was completed. The first irradiation test of a thin-walled tube of uranium metal was concluded. Preliminary postirradiation examination of six Zircaloy-clad tubes of compacted uranium oxide revealed cladding defects in four of the specimens. The tubes had been fabricated by a combination of sonic vibratory compaction and cold-swaging. (For preceding period see DP-565.) (auth)

13976 (GA-1100) SAFEGUARDS REPORT FOR THE MGCR CRITICAL EXPERIMENT. L. R. Amyot, A. J. Goodjohn, S. H. Levine, A. D. McWhirter, J. M. Stein, and H. A. Vieweg (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Dec. 18, 1959. Contract AT(04-3)-187. 132p.

A description is given of a critical facility for the Maritime Gas-cooled Reactor. The flexibility of the assembly design permits the use of either BeO or graphite as a moderator. Descriptions are given of the buildings, assembly, associated equipment, procedures, and planned experimental program. Salient features of the facility include large honeycomb aluminum assembly, a Met-L-Flex shock absorber, 24-hr neutron monitoring, U^{235}-activated BF_3 fuses, and a specially designed fuel assembly which, in case of fuel melting, assumes a much less reactive configuration. A hazards analysis is presented concerning the facility and test program, which offers evidence to show that operation of the facility will create no undue risk to the health and safety of the public or laboratory personnel. (B.O.G.)

13977 (GEAP-3287) FAST OXIDE BREEDER-REACTOR. PART I. PARAMETRIC STUDY OF 300(e) MW REACTOR CORE. P. Greebler, P. Aline, and J. Sueoka (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Nov. 15, 1959. Contract AT(04-3)-189. 59p.

Physics scoping studies of a 300-Mw(e) PuO_2–UO_2-fueled fast-breeder reactor are reported. Physics design parameters that effect fuel costs, full conservation, and reactor safety were evaluated for use in the selection of parameters for a reference design. The total breeding ratio varied from 1.1 to 1.5 in the range of parameters considered. Plutonium core loading ranged from 500 to 1500 kg. Doubling time was found to be reduced by high-density fuel and low steel content. A compromise figure on fuel-rod range of sizes (about 200 mils) yields a $2.5 operating reactivity and a small, negative sodium temperature coefficient. (J.R.D.)

13978 (GEAP-3476) SUMMARY DESIGN REPORT. THE FLUX TRAP CORE FOR A MARINE BOILING WATER REACTOR IN THE T7 TANKER. J. R. Birle (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 15, 1960. 122p. Contract AT(04-3)-189, P.A. #5.

The design is presented of a flux-trap core that was developed for a direct-cycle marine boiling-water-reactor

propulsion system. Included are a description of the core, drawings, and a discussion of core physics and thermal, hydraulic, and mechanical design considerations with emphasis on marine environmental factors. (auth)

13979 (GEAP-3508) NEUTRON AND PARALLEL FLOW CHANNEL COUPLING EFFECTS ON THE T-7 FLUX TRAP REACTOR. J. M. Case (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Aug. 15, 1960. 41p. Contract AT(04-3)-189, PA #5.

An analytical model and analog computer circuit are developed for the study of both neutron and parallel-flow-channel coupling in a large natural-circulation boiling-water reactor. The analytical model makes possible a means for the quantitative evaluation of combined neutron and hydraulic coupling effects. The evaluation includes a clear determination of the predominating coupling influence. The analog computer circuit can be easily adapted to any reactor configuration by simply calculating the necessary computer coefficients from physics, thermodynamics, and fluid-dynamics data. The analytical model indicates that the reactor core is influenced more by the effect of hydraulic coupling than by the effect of neutron coupling. (W.L.H.)

13980 (IDO-19014(Vol. II)) HEALTH PHYSICS AND RADIOCHEMISTRY FOR ARMY NUCLEAR POWER PLANTS. VOLUME II. PROCEDURES. Reynold L. Hoover, Ernest T. Borawski, Gerald S. Golden, Robert L. Hancock, and Robert L. Layfield (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). [1960]. Contract AT(10-1)-967. 156p.

Procedures are outlined for health physics, radiochemistry, and environmental monitoring in nuclear power plants. The procedures are not required for each type of power plant, but may be extrapolated for the purpose of writing manuals for any specific power plant. (B.O.G.)

13981 (IDO-28564) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM SUMMARY REPORT ON MATERIALS FOR THE GCRE-II. Ray Carpenter and Anthony Del Grosso (Aerojet-General Nucleonics, San Ramon, Calif.). Dec. 30, 1960. Contract AT(10-1)-880. 131p.

Investigations were made of various materials for development of metal-canned and semi-homogeneous GCRE-II fuel element concepts. The materials were studied for application to development of fuels, graphite, silicon–silicon carbide coatings, metal claddings, carburization barrier coatings, and graphite joining. A survey of the literature showed that uranium carbide fuels are superior to other types for the applications described and that refractory metal or metal carbide fuel coatings appear superior to other types for use with the types of graphite investigated. Experimental measurements were made of the thermal conductivity, tensile strength, stress-strain relationships, and thermal expansion of graphite powder bonded with baked carbon at a final firing temperature of 760°C. Results showed that these materials were stronger and more isotropic at all test temperatures than a standard structural graphite such as ATJ. The thermal conductivity is somewhat lower and the thermal expansion slightly higher than the corresponding properties of ATJ. A silicon–silicon carbide coating was developed as an oxidation-resistant coating for graphite. Preliminary air oxidation tests at 1000°C showed that the first samples survived 2000 hr with 10% failure. Subsequent experiments showed that it is reasonable to expect better performance in further tests. Tests for compatibility with graphite were conducted on zirconium, Zircaloy-2, "A" nickel, and K-Monel at 1750 and 1850°F for 1000 and 1500 hr. Chemical analyses, metallography, and tensile tests indicated that the K-Monel is the material most compatible with graphite; it possesses good strength and ductility with negligible carburization or carbon diffusion. Zircaloy-2 tubing showed a growth of from 3.4 to 3.8% when thermal cycled 100 times between 850 and 1850°F. Tests for compatibility with Hastelloy X were conducted on graphite samples coated with molybdenum, niobium carbide, and zirconium carbide at 1750°F and 300 psi for 1000 and 1500 hr. Chemistry and metallography indicated that all coatings tested would function satisfactorily as carburization barriers to Hastelloy-X. Graphite joints using various fillers and binders were fabricated and tensile-tested at room temperature. Joints using a selected combination of C-6 filler and polymerized furfuryl alcohol as binder produced maximum tensile strength of 2000 psi. (auth)

13982 (LAMS-2482) TURRET PRELIMINARY NUCLEAR CALCULATIONS. B. M. Carmichael and R. E. Peterson (Los Alamos Scientific Lab., N. Mex.). Dec. 1, 1960. Contract W-7405-eng-36. 47p.

A preliminary study of the nuclear parameters of the Turret reactor is described. It is estimated that at the design operating temperature of 1350°C and power of 3 Mw(t) the critical mass will be 7.1 kg of highly enriched uranium. An estimate of 21% Δk is obtained for the amount of shutdown control needed, and it is calculated that the proposed three-ring control rod system will provide 28% Δk shutdown control. A slow negative temperature reactivity coefficient of 1.4×10^{-4} $(\Delta k/k)/°C$ is found, and a negative prompt reactivity coefficient of the order of 10^{-5} $(\Delta k/k)/°C$ is envisioned. (auth)

13983 (MND-M-1853(Add.I)) PM-1 NUCLEAR POWER PLANT ADDENDUM TO HAZARDS SUMMARY EVALUATION. W. Haass and J. Sieg (Martin Co. Nuclear Div., Baltimore). Feb. 1961. 236p. Contract AT(30-1)-2345.

A description is given of the final design of the PM-1 Nuclear Power Plant, including the changes made during the final design. The design changes did not affect the conclusions reached in the original hazards evaluation. (B.O.G.)

13984 (NAA-SR-5348(Rev.)) DESIGN MODIFICATIONS TO THE SRE DURING FY 1960. G. E. Deegan, M. D. Dermer, J. S. Flanagan, G. C. Gower, R. J. Hall, R. B. Hinze, D. H. Johnson, R. W. Keaten, and W. H. Olson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 15, 1961. Contract AT-11-1-GEN-8. 108p.

The means used to prevent the recurrence of tetralin leakage into the SRE sodium systems are discussed. Included is a description of the redesign of system components to utilize alternate coolants such as nitrogen, air, and NaK. The use of kerosene to replace tetralin, where double containment is provided, is discussed. The physical properties are compared, and kerosene is shown to be free of the undesirable characteristics of tetralin. The fuel-element cleaning system was redesigned for steam washing, followed by a water rinse and vacuum drying. Hydrogen gas evolved during washing is oxidized with copper oxide to eliminate the possibility of a hydrogen-oxygen explosion if air should accidentally enter the vent system. The fuel element was changed from a seven- to a five-rod cluster to provide additional clearance in the channel. Element hardware was modified to provide an orifice location which will permit more precise flow calculations; a redesigned hanger assembly which will minimize sodium holdup; and filter screens at the channel entrance to prevent in-cluster plugging. Diagnostic instrumentation was provided for the reactor to monitor: fission-product activity in the reactor cover gas; rapidly varying reactor parameters during a

reactor scram; internal and sheath fuel temperatures; and functions being performed which will indicate the mode of operation. The data will provide additional information to the reactor operator, as well as provide a more comprehensive coverage for reactor analysis. (auth)

13985 (NAA-SR-5445) DESIGN AND THERMAL ANALYSIS OF SODIUM SPECIALTIES COMPONENTS FOR HNPF. W. M. Hoschouer and D. F. Casey (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 15, 1961. Contract AT-11-1-GEN-8. 49p.

Reliable sodium specialties components were developed for The Hallam Nuclear Power Facility. These components are as follows: (1) A sodium cold trap (thermal precipitator for oxygen removal) capable of lowering the oxygen concentration of a sodium system to approximately 5 ppm. This component is capable of operating efficiently even after reaching its design capacity of 200 lb of Na_2O; (2) A plugging meter (instrument to measure oxygen saturation temperature) capable of detecting oxygen concentration to 5 ppm while under fully automatic operation; and (3) A freeze trap (sodium system gas vent) which will vent a large sodium system and automatically seal off the system with entering sodium at 1000°F. This component will also allow venting the system and resealing while operating at 1000°F. Thermal analysis, design basis, and experimental data for all three are discussed. (auth)

13986 (NAA-SR-Memo-2139) PRELIMINARY RADIATION SURVEY OF THE SRE. J. P. Hale (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 18, 1957. 10p.

An investigation was conducted to determine radiation dosage rates associated with operation of the Sodium Reactor Experiment at 8.3 Mw. These values were extrapolated to full-power operation. Radiation survey results are tabulated. (J.R.D.)

13987 (NAA-SR-Memo-4486) CORE PARAMETER STUDY FOR A 300-MW SODIUM GRAPHITE REACTOR. W. P. Corcoran (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 22, 1959. 70p.

A core parameter study of the operating costs was performed for a 300-Mwe sodium graphite reactor, a scale-up of the Hallam Power Reactor. The results of the study indicate that the core design is near optimum and that core modifications would reduce the power costs by less than 5%. The lattice spacing, fuel rod diameter, and sodium flow can be varied within a rather broad range without significant changes in power generation costs. The effect of the fuel cladding thickness is more significant; fuel cycle costs can be reduced if stainless steel canning is replaced with zirconium canning. Use of UC in place of uranium–molybdenum fuel would also permit cost reductions. (D.L.C.)

13988 (NAA-SR-Memo-5287) CAUSES OF SURFACE FILM FORMATION AND MEANS FOR PREVENTING FILMS IN ORGANIC REACTOR SYSTEMS. W. E. Parkins (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 21, 1960. Contract AT-11-1-Gen-8. 50p.

The processes leading to film formation in the OMRE, the role of coolant particulates in film formation, the prevention of film formation in the OMRE, and the prevention of film formation in power reactors are discussed. (W.L.H.)

13989 (NAA-SR-Memo-5399) SUMMARY OF EOCR NUCLEAR ANALYSIS. R. W. Hardy (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 22, 1960. 26p.

A summary of nuclear calculations related to the experimental Organic-cooled Reactor core is presented. Schematic layouts of the core are included. (J.R.D.)

13990 (NAA-SR-Memo-5462) NUCLEAR PARAMETER STUDY OF A MOLTEN FUSED OXIDE BREEDER REACTOR. H. Alter (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 29, 1960. 25p.

The effects of varying the Na_2O/P_2O_5 ratio in the molten oxide fuel on the reactor parameters of a fused oxide breeder reactor were determined at several concentrations of UO_2 and U^{235} enrichments. The Na_2O/P_2O_5 molar ratio was varied from 0.75 to 1.42, and the corresponding variations in the parameters were found to be relatively small. However, on the basis of the critical mass and core radius, the higher ratios appear to be more favorable. A parameter comparison was also made for a ratio of 1.1 between UO_2 and PuO_2; the results indicate that PuO_2 is the most desirable fuel. (D.L.C.)

13991 (NAA-SR-Memo-5464) OPERATING EXPERIENCE WITH THE SODIUM REACTOR EXPERIMENT AND ITS APPLICATION TO THE HALLAM NUCLEAR POWER FACILITY. R. J. Beeley and J. E. Mahlmeister (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [1960?]. 45p.

The Sodium Reactor Experiment (SRE) was constructed to demonstrate the feasibility of sodium-cooled graphite-moderated reactors for central station power. The operating experience of SRE has provided valuable data for the design of the Hallam Nuclear Power Facility (HNPF) now under construction. Some of the difficulties found in the SRE, which HNPF will be designed to avoid, are the sodium-sodium intermediate heat exchanger (horizontal position in SRE gave trouble; a vertical position will be used in HNPF), sodium pumps, handling of broken fuel elements, and excessive thermal stresses due to inadequate coolant flow. Other features of HNPF include the addition of an activity monitoring system for the core cover gas, elimination of tetralin for auxiliary cooling of plant equipment, instrumentation of fuel elements, and addition of carbon traps in the primary sodium system. SRE operation has demonstrated unusual reactor stability and capability for rapid power changes. (D.L.C.)

13992 (NDA-2653-1) APPLICATION OF BERYLLIUM METAL TO NUCLEAR POWER REACTORS. M. Raber, R. Hankel, and G. Sofer (Nuclear Development Corp. of America, White Plains, N. Y.). Nov. 30, 1960. 72p. For Brush Beryllium Co., Cleveland.

A review was made of potential applications of beryllium metal in nuclear power reactor types under development. The results of the study indicate beryllium metal to be economically attractive for use as fuel cladding and core structural material in central station nuclear power reactors, promising significant savings in total energy cost at projected beryllium prices. (auth)

13993 (ORNL-3049) GAS-COOLED REACTOR PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1960. (Oak Ridge National Lab., Tenn.). Mar. 9, 1961. Contract W-7405-eng-26. 345p.

Pebble-Bed Reactor Studies. Design studies were carried out of the pebble-bed reactor which was indicated to be potentially capable of producing low-cost power. A preliminary design was prepared for a 10-Mw experimental reactor with which to obtain sufficient data for the de-

sign of a full-scale pebble-bed power reactor. The second study produced a design of a 330-Mw(e) power plant based on a parametric analysis of the design requirements. Reactor Physics. A zone-loading pattern for the EGCR was designed as a compromise between the requirements for power flattening and the desire for high loop power. Reactivity effects associated with operation of the EGCR were studied to obtain data needed for determining the control actions that must be available. Calculations were made of the neutron source required for the EGCR. Studies were made of the flux levels at EGCR shield penetrations and the dose rates around the charge and service machines. Calculations of the heat deposition in the EGCR core included the additional heating by γ rays originating in a loop experiment and the heating effect of fast neutrons. Reactor Design Studies. The thermal behavior of the EGCR fuel assemblies was analyzed in terms of the effect of control programing and mode of operation. The ORNL analog computer was used to analyze EGCR fuel temperatures during the following transients: (1) the extremes of the normal conditions; (2) variations caused by loss of gas flow; (3) variations caused by reactivity increases, and (4) variations caused by loss of power. Preliminary designs were prepared for four types of beryllium-clad fuel elements for use in alternate fuel assemblies for the EGCR core. Correlation studies were made of mass- and heat-transfer data applicable to EGCR fuel assemblies. The design of the EGCR control rod was modified, and a full-scale mock-up is being assembled to establish fabricating techniques. A method for decontaminating EGCR components was developed. A kinetics study of the oxidation of H_2, CO, and CH_4 in a flowing stream of helium in a fixed bed of Girdler G-43 platinum catalyst was completed. In EGCR hazards evaluations, the possibility of the ignition of graphite if air entered the system because of a rupture was considered. A review of the maximum credible accident postulated for the EGCR was made. An empirical representation of the neutron exposure of the moderator columns in the EGCR was developed for use in evaluating the induced stresses. Fast-neutron exposure leads to bowing of the EGCR graphite columns, and an evaluation of the deflection of each column is required as a basis for designing the supports. Instantaneous collapse and creep buckling tests of type 304 stainless-steel cylindrical shells were conducted to obtain data applicable to the experimental tubes in the EGCR. An experimental stress analysis was made of a spherical shell with an attached nozzle in order to check the hypothesis that the total stresses resulting from combined loadings may be obtained by linearly adding the stresses corresponding to each component separately applied, so long as the elastic limit is not exceeded. An analysis was made of means for reducing thermal stress in the region of the junction of the pressure-vessel body and the flange that forms a part of the volute of the compressor for GCR-ORR loop No. 2. Experimental Investigations of Heat-transfer and Fluid Flow. Analytical studies of heat-transfer data obtained with a 2:1 ligament-ratio spacing and inlet screens are continuing, based on complete transverse mixing of the gas stream. Recent mass-transfer experiments indicated that the mass-transfer factors approached a higher asymptotic value in the downstream section of the tube cluster than in the upstream region. The accumulation of data for delineating the velocity field in the downstream element of two EGCR clusters was continued. An experimental program was initiated to establish the magnitude of intra- and inter-cluster mixing. Materials Development. The conditions for fabrication of UO_2 specimens with controlled grain sizes for use in various experiments were studied. Several modifications were made to the apparatus developed for measuring the thermal conductivity of UO_2. The coefficient of thermal conductivity of INOR-8 alloy was measured up to 700°C with a precision of ±1%. A comparison of data from Chalk River on fission-gas release from UO_2 with ORNL data on duplicate specimens shows poor correlation, except for specimens with high BET surface areas. Rates of fission-gas release from a fine-grained dispersion of UO_2 in BeO were measured at 1200 to 1800°C. Fine-grained dispersions of UO_2 plus ThO_2 in BeO were fabricated for use in high-temperature irradiation experiments. Several binder materials considered for use in graphite fabrication were found to have adverse reactions with UC. The fabrication of graphite fueled with coated and uncoated particles of UC_2 was studied. The cause of cracking in arc-cast UC cylinders was determined to be the result of rapid cooling. The loss of material from UC during high-temperature sintering was studied with a mass spectrometer. The oxidation resistance of uncoated and siliconized SiC-coated graphite samples was determined. The mechanical properties of several commercial high-density grades of graphite were determined. The grain growth of type 304 stainless-steel tubing during brazing of spacers at 2150°F was previously shown to promote premature failure in tube-burst tests. The substitution of copper, brazed at 2020°F, resulted in much less grain growth. Thermal cycling of simulated EGCR fuel elements was found to cause axial elongation of the cladding in the elements having no diametral gap between the cladding and fuel pellets. The oxidation of type 304 stainless steel in low concentrations of $CO-CO_2$ mixtures in helium was found to be insignificant below 1200°F, while above this temperature the oxidation rates are dependent on temperature but independent of the total content or the ratios of CO and CO_2. Carburization of type 304 stainless steel was found to depend on the temperature, the CO_2/CO ratio, and the reaction time. Methods were studied for fabricating in-pile capsules and instrumented fuel assemblies containing thermocouple wells and tungsten-rhenium thermocouples. High-temperature mechanical properties of ferritic steel-to-stainless steel welds were determined. Defects as small as $\frac{1}{8}$ in. in diameter in V-groove welds on EGCR loop through-tubes can be detected by a through-transmission ultrasonic technique. Lack-of-fusion areas that were undetected by visual and radiographic inspection were found by this technique and confirmed by metallographic examination. The oxidation rates of extruded or hot-pressed beryllium in CO_2 were found to compare favorably with previous data on beryllium powder. Metallographic examinations were made of surface cracks and internal pits detected in beryllium tubing. Welding and brazing studies on beryllium continued with emphasis on end closures of tubes. Approximately 150 tube-burst specimens of beryllium were fabricated, with a rejection rate of about 10%. In-Pile Testing of Components and Materials. Irradiation of prototype EGCR fuel capsules in the ETR and the group III capsules in the ORR was continued. Irradiations of small specimens of $BeO-ThO_2-UO_2$ and UC were initiated. Irradiation of the second graphite-encapsulated test element fueled with a UC_2-graphite matrix was completed. Postirradiation examinations of LITR-irradiated specimens were continued. Information on the effect of irradiation on density and grain growth was collected. The nondestructive examinations of the ORR-irradiated group II capsules were completed. The thin-plate UO_2 sample that was used as the source for instantaneous fission-gas-release experiments was examined. A sample of high-density UO_2 clad in low-permeability graphite coated with pyrolytic carbon was irradiated to evaluate the effectiveness

of the carbon-coated graphite in retaining fission gases. Since the properties of UO_2 fuel elements are sensitive to the oxygen-to-uranium ratio, techniques for determining the ratio in irradiated material were investigated. Out-of-pile tests of enriched UC_2 dispersed in graphite and canned in Si–SiC-coated graphite have shown no weight or density changes. Equipment for irradiating pressure vessel steels in the ORR was completed. The high-temperature experiment for studying the irradiation-induced swelling of beryllium was completed. In-pile tube-burst type stress-rupture tests of type 304 stainless steel have shown that at 1500°F neutron bombardment reduces the rupture strength by about 1500 psi in the stress range studied, i.e., 3000 to 6300 psi. Out-of-pile Testing of Materials and Components. A test of graphite and structural materials in flowing helium containing controlled amounts of CO_2 and CO was completed. Tests were carried out on a small-scale model of the EGCR purification system for determining the effectiveness of the system in removing gaseous impurities from circulating helium. Experimental studies of the degassing behavior of selected grades of graphite were continued. A series of room-temperature permeability determinations was made on a typical EGCR moderator graphite block. Means for the removal of radioactive iodine vapor from high-temperature helium streams were studied. Investigations of adsorbers for radioactive krypton and xenon were continued. Further study of the negative emf drifts experienced with Chromel-P in stagnant helium at 1000°C indicated that the principal mechanism involved is the selective oxidation of chromium in the thermal-gradient region (800 to 900°C). Theoretical calculations from thermodynamic data indicate that it should be possible to selectively oxidize chromium to Chromel-P with a mixture of water vapor in hydrogen. Preliminary experiments indicated that Chromel-P–Alumel thermocouples sheathed in type 304 stainless steel were showing a negative emf drift while exposed to a graphite-helium atmosphere at 870°C. Thermocouples sheathed with type 310 stainless steel did not show a negative drift. Development of Test Loops and Components. Work continued on the design of the EGCR in-pile loops. Construction work continued on GCR-ORR loop No. 2. Electrical breakdown tests were made of heaters and a microswitch proposed for use in EGCR loops and ORR loop No. 2 to establish operating characteristics. A ball valve with a Limitorque operator for use in the EGCR was tested in a furnace at ~1000°F. Three 5-in.-IPS double-seal gas-buffered Conoseal joints and two 6-in.-IPS double seal gas-buffered Grayloc joints were tested. The two regenerative compressors that were installed in the twin-turbine vessel of ORR loop No. 1 operated satisfactorily for ~1000 hr. The study of back diffusion through labyrinth type seals was completed. (For preceding period see ORNL-3015.) (auth)

13994 (ORNL-3061) HOMOGENEOUS REACTOR PROGRAM PROGRESS REPORT FOR PERIOD FROM AUGUST 1 TO NOVEMBER 30, 1960. (Oak Ridge National Lab., Tenn.). Mar. 6, 1961. Contract W-7405-eng-26. 113p.

Homogeneous Reactor Test. The program of reactor maintenance and major repairs to the core tank was completed. Both core-vessel holes were patched and leak tested. Tools were developed to measure core-vessel thickness in the cone section and to examine and photograph the inner surface at high magnification. A new core circulating pump with inlet and outlet piping revised was installed in order to reverse the direction of fuel flow. The HRT resumed nuclear operation and was brought to criticality on Nov. 7. Preliminary evaluation of the new hydroclone system indicated that the efficiency is not greater than that of the original unit. Fluid age measurements in the flow model of the HRT core indicated that the bulk temperature of the core should be about 20% above the outlet temperature. A conceptual design and criticality calculations were made for a cylindrical HRT replacement vessel. Calculations of the pressure use in the HRT were performed for various reactivity-rate additions and several operating conditions. Critical fuel concentrations were also calculated for different variables. Engineering Development. Testing of the straight-through core vessel was continued. Alumina bearings were operated in high-temperature water in a 200-gpm pump for 6970 hr. The drive system of the three-stage oxygen compressor was revised in an attempt to prevent diaphragm failures. The operation of capillary viscometers with a particular pumped thoria slurry at 30°C showed that all pseudoshear diagrams fell on a single curve. Solution Fuels. Tracer-level experiments showed that protactinium was coprecipitated with thorium from aqueous acid thorium nitrate solutions when H_2O_2 was added in an amount sufficient to precipitate no more than 3% of the thorium. The solubilities of H_2 in H_2O and of D_2 in D_2O were determined. The temperatures for the appearance of liquid-liquid immiscibility were determined for two homogeneous-reactor fuel solutions and their concentrates. Liquid-liquid equilibria in the systems UO_3–CuO–SO_3–D_2O and CuO–SO_3–D_2O were studied. Solubilities of $3CuO \cdot SO_3 \cdot 2D_2O$ at 300, 325, and 350°C were determined in solutions of D_2O and D_2SO_4. Measurements of electrolytic conductance of 0.01M KCl solutions were made at pressures up to 400 atm. Three-dimensional models representing solubility relations in the system UO_3–CuO–NiO–SO_3–D_2O at 300°C were constructed. An all-titanium pump loop was constructed to study the chemical stability of uranyl sulfate fuel solutions and the corrosion resistances of various materials at temperatures and pressures up to 370°C and 3000 psia. A review and correlation of Zircaloy-2 radiation corrosion data are presented. An experiment to test Zircaloy-2 corrosion in the HRT core is described. Data from batch autoclave tests of uranium sorption on hydrous zirconia from uranyl sulfate solutions are reported. Slurry Fuels. Radiation effects on a settled bed of thoria pellets in D_2O were determined. Data obtained in recalibration of gas-injection apparatus showed little or no deactivation of a sol-prepared palladium catalyst by excess oxygen partial pressures. The effects of ball-mill charge, mill length, and rotational speed on the wear rate of thoria pellets were studied. Corrosion and size degradation during irradiation of thorium slurry in in-pile loops was investigated. Fuel Manufacture. Methods of minimizing cracking and poor resistance to attrition of spherical thoria pellets are discussed. Spherical thoria pellets were successfully coated in a plasma-jet apparatus with Al_2O_3, Ta_2O_5, ZrO_2, TiO_2, Ni, and Cr. Flame calcination of thoria sols in the 1500 to 1600°C range gave rounded particles of ThO_2 having mean sizes of 2.7 and 4.6μ. Metallurgy. A 3.5-kg batch of rounded-end ThO_2 pellets with densities between 9.0 and 9.3 gm/cm^3 was successfully produced. Fabrication studies were conducted on methods for constructing Zircaloy-2 replacement core vessels. Analytical Chemistry. An amperometric method for the determination of thorium in slurries of ThO_2 and in fuels for the molten-salt reactor is described. Microgram quantities of thorium in reactor materials were determined by an indirect polarographic method. A method to eliminate interferences in the flame photometric determination of calcium is discussed. (For previous period see ORNL-3004.) (M.C.G.)

13995 (TID-5841) ATOMIC ENERGY COMMISSION–BUREAU OF MINES PROCESS HEAT REACTOR PRO-

GRAM. Quarterly Progress Report, August 1 to October 31, 1959. L. L. Hirst, J. P. McGee, G. R. Strimbeck, and N. H. Coates (Bureau of Mines. Appalachian Experiment Station, Morgantown, W. Va.). 26p.

Runs were made with the 250 psig pilot-scale helium recycle loop. After Run No. 10, the heat exchanger was removed from the system and cleaned. In addition, particulate matter was blown out of the loop, and a new filter was installed. During Run No. 11 a leak developed in the helium-to-air heat exchanger. The system was shut down. A water-to-helium cooler was installed, and the run was continued. The run was terminated when large deposits of particulate matter in the loop caused inconsistent helium flows. After Run No. 11, a new helium recycle compressor was installed in the loop. A new helium cooler was constructed and installed in the loop. This unit has two heat-exchange sections in series. Helium is cooled by indirect exchange with water in the first section and by indirect exchange with air in the second section. A maximum gas temperature of 2500°F was reached during Run No. 12, but a hot spot on the shell of the ISR (induction-heated simulated-nuclear reactor) caused termination of the run after 107 hr. Two tungsten-coated tubes were tested at high temperatures and pressures in a helium atmosphere to determine whether or not tungsten coatings provide greater strength than an equal thickness of alloy steel. From results of the tests, it was concluded that sprayed tungsten coatings provide no additional strength of 310 stainless-steel tubes at high temperature. A system was designed for life-testing promising commercially available alloy tubes for use in coal gasification. Two types of spherical graphite fuel elements were tested for durability at 2500°F in the presence of air. One type, coated with 1 to 3 mils of silicon carbide, cracked after 150 hr. The other element, with a $\frac{1}{32}$-in. KT type silicon-carbide coating, showed no evidence of cracking or deterioration after 482 hr at 2500°F. A vacuum-tight apparatus for the detection of impurities in helium was constructed. It is essentially an incandescent tungsten filament that reacts readily with impurities, particularly oxidizing contaminants. Oxides were formed which sublimed well below the melting point of the filament. Tests completed thus far showed the necessity of completely degassing the system prior to any helium flow. The time required to outgas the system at given temperatures is now being investigated. A laboratory-scale helium-heated coal gasifier was constructed to show the feasibility of gasifying coal-water slurries in alloy-steel tubes with heat transferred from helium at 2400°F. Tests on the electrostatic precipitator were completed at the datum temperature of 600°F and pressures of 5 to 80 psig. Dust-removal efficiency of the apparatus increased from about 85% at 5 psig to 99% at 80 psig. (auth)

13996 (TID-6612) NUCLEAR-ENERGY POWER SOURCES. George H. Ogburn, Jr. (Army Signal Research and Development Lab., Fort Monmouth, N. J.). Feb. 1961. 15p.

Presented at the Fourteenth Annual Power Sources Conference, May 17-19, 1960, Atlantic City, New Jersey.

A discussion is given of the feasibility of the application of nuclear energy as a source of electrical power where interest concerns small light-weight sources capable of operating unattended for long periods of time in remote or inaccessible areas. Radioisotope and reactor energy sources are discussed, with emphasis placed on the SNAP program developments. Characteristics are given for the SNAP-1A, -3, and -10 reactors. (B.O.G.)

13997 (TID-6815) THE SNAP II POWER CONVERSION SYSTEM. Topical Report No. 6, Bearing Design and Development. Warren D. Waldron (Thompson Ramo Wooldridge Inc., Cleveland). June 22, 1960. 69p. (ER-4102).

A preliminary analysis conducted on various types of bearings indicated that hydrodynamic type journal and thrust bearings lubricated with a portion of the mercury from the condensate return pump would best suit the SNAP II requirements. Experimental results confirmed the bearing design approach. Stable bearing operation was obtained at speeds in excess of the 40,000 rpm design objective with simulated loads of 1 to 10 g in the radial direction, and 0 to 2 g in the axial direction. Total power consumption of the bearing system is approximately 550 watts at the design speed. (auth)

13998 (TID-6937) CONCEPTUAL DESIGN: PROTOTYPE BOILING WATER REACTOR (50 MWe). (Sargent and Lundy, Chicago and Argonne National Lab., Ill.). Aug. 21, 1959. Contracts AT(11-1)-747 and W-31-109-eng-38. 273p. (SL-1647)

A report is presented which contains pertinent design, construction, and other descriptive information related to a boiling-water reactor power plant having a net electrical output of about 50,000 kw. The primary purpose of the plant is to demonstrate the potential of high specific power in the reactor core and the ability to sustain long fuel exposure. The design parameters were selected to demonstrate as closely as practicable the desired conditions for a 250 Mw(e) boiling-water reactor plant. Included are descriptions of the reactor, turbine plant, auxiliary systems, buildings and site, and construction schedule. (J.R.D.)

13999 (TID-11025) ANALYSIS AND SIMULATION STUDY OF THE OPERATING CONTROL SYSTEM FOR THE ENRICO FERMI ATOMIC POWER PLANT. Report No. 59-12. (Holley Carburetor Co., Warren, Mich.). Nov. 1, 1959. 302p. For Power Reactor Development Co., Detroit.

Includes Addendum No. 1 (EM60-1). Jan. 15, 1960.

An analog simulator was developed to simulate one of the three circuits of the Enrico Fermi Power Plant. Included in the simulation were the reactor, intermediate heat exchanger, mixing and transport delay phenomena, and steam-system hydraulics. Revisions and additions to the steam-system simulation and refinements of the automatic feedwater-steam control subsystem, as simulated, are outlined in the addenum. (J.R.D.)

14000 (WANL-PR(A)001) 3MW(e) NUCLEAR THERMOELECTRIC POWER PLANT PROGRESS REPORT, MAY-AUGUST 1960. R. A. Clark, Jr., R. A. Doncals, and R. R. Holman (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). [Decl. Jan. 13, 1961]. Contract NONR-3216(00). 73p.

The reference thermoelectric generator element was selected as one that will give an over-all conversion efficiency of 7% for a practical generator, including allowance for contact losses and other assembly degradations. Preliminary hydraulic, thermal, and nuclear design analyses were used to establish a reference core for lifetime and control studies. An approach to the system concept was selected, based on convective flow using light water at 2500 psi, which is self-pressurized and has two-phase heat transfer with rejection of waste heat directly to the sea water. The control concept, yet to be analyzed, assumes stable self-regulation for fast transients through void and temperature control, regulation of recirculation rate for the slower transients of depletion mismatch, fission-product poison and results of load change. A mathematical model was selected for the control analysis and is being

adapted to an analog computer. Reference materials were selected for structural, core, and thermoelectric generator parts. A prototype electromechanical design was made for a thermoelectric assembly and test facility to be used for performance testing under pressure, temperature, and electrical stresses simulating the reference generator. Testing facilities were procured for compatibility tests for higher temperature coolants. Tentative design information indicating summary performance capabilities currently considered feasible is listed. (auth)

14001 (WAPD-TM-263) FISSION GAS RELEASE IN PWR CORE 1 BLANKET FUEL RODS UPON CONCLUSION OF SEED 1 LIFE. B. Rubin (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Feb. 1961. Contract AT-11-1-GEN-14. 20p.

Zircaloy-clad natural-UO_2 fuel rods were removed from the blanket of the PWR (Shippingport) reactor at the conclusion of the first seed life (5800 EFPH), and the amount and composition of evolved fission gases were determined. At burnups of about 1.6×10^{20} fissions/cm^3, fission gas releases of approximately 0.4% of the total amount theoretically generated within the fuel were measured; these corresponded to previously determined experimental values and also to those predicted by diffusion theory. (auth)

14002 (WCAP-1715) THERMOELECTRIC NUCLEAR FUEL ELEMENT. Monthly Progress Report No. 31, Covering the Period January 1961. G. R. Kilp, W. P. Blankenship, K. J. Gill, R. C. Goodspeed, P. V. Mitchell, and E. G. Schwartz (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Feb. 10, 1961. Contract AT(30-3)-500. 13p.

Differential thermoanalysis data secured for PbTe samples representative of several doping levels indicated that the melting points were independent of doping levels. A US sample melted in a tantalum bomb is being swaged and heat treated for measurement of its thermoelectric properties. A PbTe test element is being set up to furnish axial temperature distribution data. Equipment was set up for momentarily bucking out the Seebeck voltage of test elements so that more accurate determinations could be made of the small IR drop used for resistivity measurements. A magnesium silicate, AlSiMag 222, was adopted to replace Lavite as insulation in thermoelements. Specimens are being made to determine correlations between the PbTe physical properties study and microstructures and thermoelectric properties versus time and temperature. A new PbTe-insulating materials study, to include the AlSiMag 222, is underway. Lowering conductor resistance in thermoelements and optimizing relative dimensions of N- and P-type materials in a dimensionally varied element were calculated to yield a 45% increase in efficiency. Cylindrical and spherical reactor configurations might well be feasible for thermoelectric applications with output independent of hot channel factor, according to design studies. (auth)

14003 (WCAP-4051) CVTR PROJECT. CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC., MONTHLY PROGRESS REPORT, JANUARY 1961. Contract AT(30-1)-2289. 28p.

The A-2 and A-4 capsules for the irradiation program were completed in preparation for insertion in WTR during February. The M-1 and M-3 capsules remain under irradiation. The In-Pile Loop has now accumulated about 50 equivalent full-power days of exposure, or 25% of the desired full-power exposure. Fabrication of the remaining ten pieces of integral finned tubing (cladding) for CVTR was completed. No major processing problems were encountered. The tubing will be shipped to WAPD for inspection during February. Some difficulties were experienced in welding Phase II fuel-rod end closures. Shrinkage defects were detected, apparently caused by an unbalanced weld bead cooling rate between the closure end plug and the fuel tubing. Further test welds are being made in order to improve techniques for the single pass weld. Experiences on repairing defective welds have resulted in 90% reclamation. Work continued on CVTR first-core burn-up and power-distribution calculations. CANDLE results indicate prior estimates of first-core U-235 content will have to be increased. Fabrication of all the CVTR Phase II components and hardware was completed. The pressure-tube assembly was installed in Loop D and testing was started. Debugging of the impulsive-burst testing machine indicated a need for minor modifications. Trial runs were made with a stainless-steel specimen. A jumper connector and port (Conoseal) test fitting was subjected to 149 thermal cycles at 100 to 520°F at 1800 psig. Maximum leak rate was less than 1 lb/year. A layout of the four-baffle concept was completed and detailing started. A vacuum drying test was conducted using the Phase I pressure tube containing one fuel assembly. The pressure tube was completely dried of approximately 39 liters of water in 15 hr. All the components required for the construction of the control-rod drive assembly were completed. Assembly of the components is nearing completion. The critical experiments were continued with the measurement of the temperature coefficient. The net reactivity change between 22 and 840°C was measured as −1.5% Δk. Measurements of the coolant void coefficient were made at the critical facility for various purities of heavy water. With D_2O of approximately 90% purity, the coefficient was found to be $+1 \times 10^{-4}$ Δk per tube. With D_2O of approximately 95% purity, the coefficient was only slightly positive, $+2 \times 10^{-5}$ Δk per tube. As a result the heavy water coolant in the CVTR will be maintained above a specified purity, which remains to be determined. (For preceding period see WCAP-4002.) (auth)

14004 (AEC-tr-4323) INVESTIGATION OF THE TRANSFER OF RADIOACTIVE MATERIALS BY STEAM AND WATER, AND OF THE CHEMICAL STABILITY OF SCALE IN A STEAM–WATER LOOP OF THE FIRST ATOMIC ELECTRIC POWER STATION. (Issledovanie Perenosa Radioaktivnykh Veshchestv Parom i Vodoĭ i Khimicheskoĭ Stoikosti Otlozhenĭ v Parovodyanoi Petle Pervoĭ Atomnoĭ Electrostantsii). P. N. Slyusarev, G. N. Ushakov, O. V. Starkov, L. A. Kochetkov, L. N. Nesterova, and V. Ya. Kozlov. Translated from Atomnaya Energ., 9: 98-103(1960). 12p.

The processes of the transfer of radioactive substances by steam and water in a loop mounted in the first cycle of the power station were investigated. The amount of scale deposited on the internal surfaces of the tubes was determined, and the chemical stability of the scale was studied. Decontamination of certain types of high-pressure equipment of the power station was investigated. (D.L.C.)

14005 (CEA-tr-A-848) LES QUESTIONS DES GARANTIES CONCERNANT COMBUSTIBLES DES PILES ATOMIQUES POUR NAVIRES. (The Questions Concerning Fuel Safety for Atomic Reactors in Ships). H. Hardung-Hardung. Translated into French from Zweite Reaktortagung der Studiengesellschaft zur Förderung der Kernenergieverwertung in Schiffbau und Schiffahrt, Kongress bei Hamburg, 25-28 November, 1959. 12p.

The problems involved in the guarantee of fuel elements for maritime reactors as to longevity, power output, and safety are discussed. The performance of a fuel element

in a reactor cannot be predicted precisely at present nor can the conditions existing in a reactor be predicted with any certainty. The conditions for a naval reactor are unique, providing even more unanswered questions. The properties of the fuel element before going into the reactor can be defined well enough, and the question of useful life is essentially one of confidence in quality of fabrication. (T.R.H.)

14006 (CF-60-11-5) OPERATING EXPERIENCE OF THE APS-1. Yu. B. Evdokimov, V. B. Litkin, V. Ya. Kozlov, V. G. Konochkin, L. A. Kochetkov, A. K. Krasin, V. S. Severyanov, B. A. Semenov, and G. N. Unakov. Translation of a paper of the IAEA Conference on Small and Medium Power Reactors, Vienna, Austria, September 5-9, 1960. 15p.

An operational review of the USSR APS-1 power station from 1954 to 1960 is presented. Included are operating information on station work at design conditions, details of work on fuel-element development, discussions of primary-circuit boiling conditions and steam superheating processes, and aspects of reactor safety. (J.R.D.)

14007 FUEL CELLS BASED ON NUCLEAR REACTORS. Tom A. Ciarlariello and Robert C. Werner (MSA Research Corp., Callery, Penna.). Chem. Eng. Progr., 57: No. 3, 42-5(Mar. 1961).

Metallic hydride fuel cells can be regenerated thermally with nuclear reactors. Such regeneration can be carried out continuously, the reactor and fuel cell forming a completely closed system in which metal hydride is fed to the reactor and dissociated in the reactor and the resulting metal and hydrogen passed back to the cell. The operation of various hydride fuel cells and reactors as heat sources are discussed. Both direct and indirect regeneration are considered; direct regeneration can be carried out by using a Li^7 solution of the metal and hydride. (D.L.C.)

14008 OPERATION OF THE SHIPPINGPORT ATOMIC POWER STATION. Francis C. Duvall (Duquesne Light Co., Shippingport, Penna.). Chem. Eng. Progr., 57: No. 3, 46-9 (Mar. 1961).

The operating experience of the Shippingport nuclear power station is analyzed with respect to the questions of whether or not it would work and whether or not it could be integrated into a utility system. The reactor makes combined use of uranium oxide pellets and U^{235} and is called a seeded reactor. The expected life of the 32 original seed elements is calculated to be 3000 full-power hours, as compared with the actual life of 5806 full-power hours. The reactor and plant and their operation is briefly described, particularly the safety precautions. One of two safety shutdown relays misfunctioned and was replaced, and criticality was attained Dec. 2, 1957. Leaks were found in some of the boiler tubes, and corrective means were taken, e.g., additional risers and prevention of free alkalinity in the boiler water. In the first 3500 hr, the reactor had fast start-up and shutdown performance and could reach 20 and 60 Mw(e) from zero power in 1 and 20 min, respectively. After 3500 hr the reactor could be operated only as a base load unit; if the load was lost, the reactor had to remain shutdown for ~40 hr to permit xenon to decay. During the last 5% of the seed-element life, load could not be dropped even a few Mw and permit operations to continue. The reactor was shutdown for seed-element replacement on Oct. 7, 1959, after 5806 full-power hours of operation. Blanket element failure is discussed. During full-power operation in Apr. 1958, a failed blanket element was indicated by high coolant activity, peaking of fission-product activity after start-up, continued release of iodine fission products after shutdown, and finally detection by a coolant sampling and monitoring system. (D.L.C.)

14009 BOILING WATER REACTOR. Edward A. Wimunc (Argonne National Lab., Ill.). Chem. Eng. Progr., 57: No. 3, 50-3(Mar. 1961).

The operating experience gained in the EBWR in the period Dec. 1956 to July 1959 is recounted. The reactor operating cycle is briefly described, and the highest radiation levels encountered in some of the major pieces of equipment during operation at 20-Mwt are presented. The operation and maintenance routines are discussed; one of the purposes of the EBWR is to show that good industrial maintenance practice is adequate for operating a boiling-water reactor. Some of the mechanical failures in the EBWR are discussed. A turbine blade broke loose at the root, and all the blades in that row were replaced. The reactor feedwater-pump thrust bearings failed several times and are now changed at intervals. In the reactor vessel, water is kept at pH 7 and a solids concentration of 0.5 to 1.0 ppm; nevertheless, serious corrosion problems resulted. Corrosion products or crud deposited on the fuel plate surfaces were found to contain 67 wt.% Al, 25 wt.% Ni, and 8 wt.% Fe and hence probably came from the aluminum dummy fuel boxes in the outer periphery of the core. The scale thickness on the fuel plates is approximately proportional to the power level. Some fuel plates (uranium alloy clad with Zircaloy-2) may grow and rupture due to the insulating effect of scale. No practical method of removing the scale from plates has been found. Another corrosion problem is caused by the particles flaking off from the scale, which settle in the control-rod-drive seal housing, causing the extension shafts to bind. The original control-rod-drive mechanisms have been replaced with a rack and pinion design, which can be blown down to remove the crud. Flake accumulations in other places, e.g., forced circulation nozzles and thimble caps, are discussed. (D.L.C.)

14010 SODIUM REACTOR OPERATING EXPERIENCE. R. E. Durand (Atomics International, Canoga Park, Calif.). Chem. Eng. Progr., 57: No. 3, 54-9(Mar. 1961).

The Sodium Reactor Experiment is described, and details of its heat-transfer system are given. An auxiliary heat-transfer system of 1-Mw capacity was installed to remove reactor afterglow heat. Pumps in all heat-transfer systems are centrifugal with frozen sodium shaft seals. The reactor was started up for the first time on Apr. 25, 1957, but reactor shutdowns were frequent for plant design modifications. For example, an eddy current brake was constructed to reduce sodium convection flow after scram, and a linear induction electromagnetic pump was installed in the line supplying sodium to the moderator coolant plenum to control the moderator temperature. Obstruction of heat transfer was observed in the sodium-to-sodium heat exchanger, and an improved heat exchanger was made. A drying system was installed to control the moisture content. After plant modifications were made, the reactor was operated at 20 Mw(t) and at ≥960°F. On May 22, 1959, in a short demonstration run, reactor temperature was raised to 1065°F for steam generation at 1000°F. Reactor stability was found to be excellent, and uneven burn-up of xenon was no problem. One June 3, 1959, the reactor was shut down because the auxiliary coolant, tetralin, leaked into the system. The leak was repaired, but in the next power run (July 12 to 26, 1959), decomposition products of tetralin fouled 13 of 43 fuel process channels, resulting in fuel-jacket destruction. The reactor was then shut down for ~1 yr to permit construction of equipment to replace mod-

erator cans and for plant modifications to prevent hydrocarbons from leaking into the sodium. A steam fuel washing facility was installed to remove the sodium residue from core elements. Maintenance of the sodium system is discussed, and techniques are given for the repair of the system. Equipment was developed for removing moderator cans and fuel-element pieces from the reactor. Detection of faulty moderator cans is briefly considered. It is claimed that the SRE operating experience since 1957 has given information equivalent to 20 years' operation of a production type power reactor. (D.L.C.)

14011 ORGANIC MODERATED REACTOR. N. J. Swanson (Atomics International, Canoga Park, Calif.). Chem. Eng. Progr., 57: No. 3, 60-3(Mar. 1961).

The equipment used in the Organic Moderated Reactor Experiment (OMRE) is described: piping, valves, gaskets, pumps, heat exchanger, and preheater. Valves utilizing extended bonnets containing Teflon bellows and flat soft-iron gaskets were substituted for those originally used. The reactor itself and its instrumentation are described in detail. Maintenance is not very different from that in a chemical or petroleum plant, except, perhaps, for the additional electrical maintenance of induction-heating circuitry. The OMRE operating experience has demonstrated the feasibility of operating organic-moderated power reactors with standard construction materials and equipment common to the chemical industries. (D.L.C.)

14012 RADIOACTIVE GASEOUS PRODUCTS FROM A HOMOGENEOUS REACTOR. C. Ciancia and M. Mandelli Bettoni (Istituto di Fisica del Politecnico, Milan). Energia elettrica, 37: 847-50(Sept. 1960). (In Italian)

A study was made on the percentage composition of the mixture of radioactive gases produced during operation of a homogeneous reactor. Data are shown for the composition as a function of the reactor operating time and the decay time of the mixture. The control of this composition for safety purposes is discussed. Maximum permissible doses in air are given for the gases. (T.R.H.)

14013 THE INFLUENCE OF COBALT AND TANTALUM IN HIGH-ALLOY CHROMIUM–NICKEL STEELS ON THE ACTIVITY IN THE PRIMARY CYCLE OF A PRESSURIZED WATER REACTOR. Rau, Schumann, and S. F. Heinrich. Energietechnik, 10: 378-86(Sept. 1960). (In German)

The maximum allowable content of Co in the primary loop of a pressurized water reactor was investigated. The problem included consideration of the Co Stellite coatings on valve seats and the Ta in welds made with Nb-stabilized electrodes. Equations are derived and used to calculate the activation of these elements and the amount of activity present in a reactor such as the Shippingport PWR. Thus the maximum allowable amounts of these elements in construction of the primary loop are obtained. (T.R.H.)

14014 FUEL ELEMENTS FOR CIVIL REACTORS. L. Grainger (Atomic Energy Research Establishment, Harwell, Berks., Eng.). Nuclear Eng., 6: No. 58, 102-11 (Mar. 1961).

The status of magnesium-canned metal uranium fuel-element development is reviewed. Substantial numbers of fuel elements received irradiations in the range 1500 to 2000 mwd/t. Studies were made on these irradiated elements in order to determine the usefulness in civil power reactors. Dimensional changes, burst development, swelling, and growth were investigated. The ductility of magnesium alloys was determined as a function of temperature and strain rate, and of material factors such as composition and grain size. The prospects for magnesium-clad uranium fuel elements is discussed, along with ways to control radiation damage. (M.C.G.)

14015 THE ROLE OF STEAM GENERATORS AT NUCLEAR POWER STATIONS USING WATER COOLANT. T. Kh. Margulova. Nuclear Energy, 107-10(Mar. 1961).

The factors involved in the use of steam generators in boiling-water reactors are discussed, e.g., water purity, condenser leakage, steam-generator position, and reactor protection. Both direct and indirect cycles are considered. A combination of direct and indirect cycles is possible in which the reactor steam drives a high-pressure turbine and then passes to a steam generator located ahead of the low-pressure turbine. In this way, the plant output can be increased without increasing the steam and corrosion-product contents in the core. Complete elimination of steam generators from nuclear power stations will be possible only if reliable and cheap filters are made for high-temperature and high-pressure use. (D.L.C.)

14016 DAMAGE TO, AND REPAIR OF THE HRE-2 CORE TANK. Power Eng., 65: No. 2, 34-6(Feb. 1961).

In two years' operation of HRE-2, between January 1958 and February 1960, several cases of overheating and severe local corrosion, melting, or burning of materials in the core occurred, and two holes developed in the Zircaloy-2 core tank. The last hole occurred in January 1960. The perforated-plate flow diffusers were also attacked and some became detached from the wall. The performance of the reactor after the development of the first hole is discussed. It was found that uranium separated from the fuel solution (0.04M UO_2SO_4 in D_2O) in amounts proportional to the power level in the 1- to 3-Mw range. The corrosion specimens were badly corroded, and pieces fell from them on the diffuser screens. From visual inspection of the first hole, it appears to have formed by melting of the core wall at that point. On the other hand, the second hole may have formed by corrosion. Equipment was developed for remotely cutting the diffuser screens loose from the core wall and closing the holes. The repair operations were begun Feb. 27, 1960, and completed in August 1960. The possible reasons for the failures are discussed. Uranium can separate from UO_2SO_4 fuel solutions in several known ways, and severalfold increases in solution concentration could be obtained under unfavorable geometric and low flow conditions such as those in HRE-2. Upward flow with low velocity tends to cause solids to accumulate on surfaces below the core equator and thus to increase heating. It is concluded that a large homogeneous reactor plant will have to be designed with inventory control so that separation of fissionable materials can be detected before the reactivity becomes uncontrollable by the negative temperature coefficient. (D.L.C.)

14017 ANOTHER STEP IN WATER-REACTOR PLANT TECHNOLOGY. A. R. Jones (Westinghouse Electric Corp., Pittsburgh). Paper No. 59-A-292. Presented at ASME Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959. New York, The American Society of Mechanical Engineers, 1959. 6p. $0.80.

A study of the technical and economic feasibility of closed-cycle water reactors is reported. The term closed cycle is chosen rather than the more commonly used term, pressurized-water reactor, because the older term implies a complete absence of boiling. As a result of the aforementioned study, it is determined that such plants are feasible in ratings up to 400 Mw(e). It is also determined that power costs reduce with increasing size up to the point at which the turbine designer changes from a tandem-compound to a cross-compound machine. This occurs at a turbine-

generator rating of about 360 Mw. A reference design at this rating is reported. A single reactor with five heat-transfer loops feeding a single tandem-compound generator is used. Detailed technical and economic analyses are carried out, and results of these analyses are reported. (auth)

14018 POWER REACTOR TECHNOLOGY. James K. Pickard, Frederick H. Warren, William W. Lowe, and Stuart McLain, eds. The Second Geneva Series on The Peaceful Uses of Atomic Energy. Princeton, N. J., D. Van Nostrand Company, Inc., 1961. 424p. $11.25.

A book on the state of nuclear power development is presented which is based on the 1958 Geneva Conference papers. The development status of design, construction, and experimental work of each current reactor concept is discussed. The reactors treated range from boiling water to homogeneous aqueous reactors. (D.L.C.)

14019 IMPROVEMENTS RELATING TO FUEL ELEMENT CANS FOR NUCLEAR REACTORS. Dermot Frederick Hughes, Maurice Roy Slack, and John Dawtrey Wallis. (to The English Electric Co., Ltd.). British Patent 861,638. Feb. 22, 1961.

A fuel element can with a larger heat-transfer surface for a gas-cooled reactor is designed incorporating discrete projections spaced from each other in both axial and circumferential directions of the can. Possible projection variations are discussed, e.g., shape and arrangement. (D.L.C.)

14020 STEAM GENERATOR. H. O. Monson. U. S. Patent 2,975,770. Mar. 21, 1961.

A steam generator is described which is capable of producing superheated steam entirely from nuclear reactor heat, without the aid of a fossil fuel supplement as in a conventional "mixed" plant. A novel three-sided heat exchanger with heated alkali metal on the shell side and two banks of tubes makes this possible; one bank of tubes connects with a boiler to produce low-pressure steam and the other bank superheats the latter.

Production Reactors

14021 (AEC-tr-4385) DESCRIPTION OF REACTORS G2 AND G3. Herreng, Ertaud, and Pasquet (France, Commissariat à l'Énergie Atomique, Paris). Translated from Report No. CEA-952. 41p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 5987.

14022 OPERATIONAL PROBLEMS OF THE ORIGINAL HANFORD PRODUCTION REACTORS. John R. Young (General Electric Co., Richland, Wash.). Chem. Eng. Progr., 56: Symposium Ser. No. 28, 42-5(1960). (HW-SA-80)

The three original Hanford production reactors and water plants are described, including a water-plant flow diagram and illustrations of the reactor and a process tube channel. The fuel-element failure, graphite distortion, tube replacement, water leak, gas leak, and radiation-exposure problems are discussed briefly. (auth)

Research Reactors

14023 (ANL-6285) ARGONAUT REACTOR DATABOOK. A compilation of experimental and theoretical results of work done with, or related to, the Argonaut Reactor to July 1960. W. J. Sturm and D. A. Daavettila (Argonne National Lab., Ill.). Jan. 1961. Contract W-31-109-eng-38. 177p.

This compilation was prepared to provide a comprehensive unified summary of the principal elements of the design, operation, and nuclear characteristics of the Argonaut Reactor. Its primary content is made up of the theoretical and experimental evaluations of basic reactor parameters, both static and kinetic, which have been made to this date. The Databook includes also some practical information on the reactivity worths of fuel, moderator, and absorbers, as well as some data on radiation in the reactor vicinity. A list of Argonaut type reactors in all countries and a bibliography of Argonaut work are included. (auth)

14024 (CEA-1397) INCIDENTS DE FONCTIONNEMENTS A EL 2 ET EL 3 ENTRE LE 1. 1. 1957 ET LE 1. 7. 1959. (Operational Accidents in EL 2 and EL 3 Between 1. 1. 1957 and 1. 7. 1959). P. Balligand (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1960. 22p.

The two most important accidents, costing 50 days out of operation for EL-3 and 43 days for EL-2 were due to the melting of a fuel rod through a cooling defect in a cell; the behavior of the fuel could not otherwise be considered responsible. (auth)

14025 (CEA-1547) ETUDE NEUTRONIQUE D'UNE PILE A NEUTRONS THERMIQUES AU PLUTONIUM: "PROSERPINE" CORRELATIONS ENTRE NEUTRONS DANS UNE REACTION EN CHAINE. (Neutronic Study of a Plutonium Reactor: Proserpine—Correlations Between Neutrons in a Chain Reaction). Jean Tachon (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1960. 123p.

Thesis submitted to Université, Paris.

The critical mass and kinetic behavior with constant and variable temperature of a homogeneous plutonium reactor are studied by theory and experiment. The core is a plutonium sulfate solution in light water, and the reflector is beryllium oxide. The lowest critical mass is 257.2 ± 1 g of plutonium. An absolute standard of reactivity permits the measurement of the effectiveness of delayed neutrons (ϵ = 1.1 ± 0.05). The measurement values of the temperature coefficient are compared with an exact calculus in two-group theory, which shows the positive contribution of the reflector. The fluctuations of the counting rate are measured against reactivity, time of counting, and the positions of the counters in the reactor. The prompt-neutron lifetime is deduced as τ = 267 ± 25 μsec. The importance of delayed neutrons in the correlations is proved and checks very well with the calculus used. (auth)

14026 (CF-60-12-118) AFTER SHUTDOWN HEATING IN THE HFIR. H. A. McLain (Oak Ridge National Lab., Tenn.). Dec. 29, 1960. Contract W-7405-eng-26. 27p.

After shutdown heating rates were calculated for the target, control plates, and the beryllium reflector of the HFIR. Decay times of 1.0, 10, 10^2, 10^3, 10^4, and 10^5 sec were considered, and heat fluxes were computed for all of the mentioned components. The greatest heat fluxes were found to be at the surfaces of the control plates and the permanent beryllium reflector. (auth)

14027 (CF-61-2-36) FUEL-CYCLE ANALYSIS AND PROPOSED FUEL AND BURNABLE POISON DISTRIBUTION AND LOADING FOR THE HFIR AND HFCE-2. R. D. Cheverton (Oak Ridge National Lab., Tenn.). Feb. 2, 1961. 51p.

Calculations were made to determine the desired radial fuel distribution in the HFIR and in the forthcoming HFIR critical experiment. In the process the design of the core was changed to include a 1-cm-thick annular space of water

between the two nearly equally thick fuel annuli, a metal-to-water ratio in the fuel annuli of 1.0 (0.050-in.-thick plates and coolant channels) was specified, and the active length of the core was increased from 18 to 20 in. Results of the calculations indicated that the largest ratio of maximum meat thickness to minimum meat thickness occurred in the inner fuel annulus and was equal to 3.6, while the maximum fuel concentration occurred in the outer fuel annulus and was equivalent to about 0.7 g of U^{235}/cm^3 of meat. The total U^{235} loading for the core was 8.01 kg, which resulted in a core lifetime of about 14 days. Other problems investigated were control-plate worth, xenon and samarium poisoning, and variations in neutron multiplication associated with the plutonium target and the core environment. Results from the latter analytical study indicate that a clean core submerged in water will be 1 to 2% subcritical, while the outer annulus (containing over two-thirds of the fuel and no burnable poison) will be 25% subcritical. (auth)

14028 (CRIO-921) HISTORY OF LOOP COMPONENT DEVELOPMENT AT THE NRX REACTOR. F. A. McIntosh (Atomic Energy of Canada Ltd., Chalk River Project, Chalk River, Ont.). July 1960. 114p. (AECL-1095)

The in-pile loops that are used with the NRX Reactor are described. Modifications in operating procedures are reviewed. (C.W.H.)

14029 (NAA-SR-Memo-681) PRELIMINARY DESIGN OF A ZIRCONIUM CANNED GRAPHITE TANK-TYPE POWER REACTOR. J. Henrie (North American Aviation, Inc., Downey, Calif.). Apr. 30, 1953. Decl. Nov. 6, 1958. 7p.

Design details of a sodium-cooled graphite-moderated power reactor of the tank type are given. The fuel elements are contained in moderator elements that are canned with zirconium. The reactor is designed so that brief shocks, e.g., earthquakes, have small effect. The canned moderator units isolate internal leaks, and the core can be inspected and serviced easily. (D.L.C.)

14030 (NP-9724) CRITICAL EXPERIMENT REACTOR GAMMA-RAY LEAKAGE STUDIES FOR RER OPERATION. R. J. Cashwell (Lockheed Nuclear Products, Marietta, Ga.). Dec. 1960. 32p. (NR-113)

Measurements made on several cores in the CER indicated that the fuel-voided-center core gave substantially increased γ-leakage flux. This core was fully investigated and checked out in the RER. To complete this phase of the program, flux mapping should be performed at the RER for 10-Mu operation. (auth)

14031 PLANNING AND CONSTRUCTION OF THE KAHL RESEARCH ATOMIC POWER PLANT. M. Ellmer (Rheinisch-Westfälisches Elektrizitätswerk A.G., Essen, Ger.) and H. Kornbichler. Atomwirtschaft, 6: 30-7(Jan. 1961). (In German)

Questions relating to the over-all planning of the Kahl research reactor are discussed. The solutions used for the primary circuit, primary auxiliary circuit, tubing and armatures, secondary circuit, safety system, water system, electrical circuits, fuel element transport, air system, and alarm system are described. The construction time table is also briefly considered. (J.S.R.)

14032 ZERO POWER TESTING OF THE REACTOR CORE. R. Misenta (Allgemeine Elektrizitäts-Gesellschaft, Frankfurt am Main) and H. Schmale. Atomwirtschaft, 6: 37-41(Jan. 1961). (In German)

The zero power testing of the Kahl reactor includes stages of loading up to the full operating core, reactivity determinations of different intermediate charge states, measurement of the temperature coefficients for various core loadings, and testing of the full operating charge. The procedures and the test results are described. (J.S.R.)

14033 RADIATION PROTECTION AT THE KAHL RESEARCH POWER PLANT. H. G. Fendler (Allgemeine Elektrizitäts-Gesellschaft, Frankfurt, Ger.) and K. Knopf. Atomwirtschaft, 6: 50-6(Jan. 1961). (In German)

Safe, accident-free operation and radiation protection both inside and outside the installation are guaranteed by measurement control and construction precautions. The measurements used to ensure safe operation, to prevent radioactive fall-out, and to monitor the reactor environs are discussed. (J.S.R.)

14034 MEASUREMENT, CONTROL, AND PROTECTION SYSTEMS FOR THE KAHL RESEARCH REACTOR PLANT. H. Schulze (Allgemeine Elektrizitäts-Gesellschaft, Frankfurt am Main), P. Nikolaus, R. Dyck, and K. Peuster. Atomwirtschaft, 6: 56-60(Jan. 1961). (In German)

The neutron flux density is measured in three mutually overlapping groups of channels. The ionization chambers always remain in operating position, while the counter tubes are withdrawn to the rest position with increasing flux density. The neutron flux is regulated with 21 control rods, 4 of which can control the range between 30% and full power. (auth)

14035 MATERIALS IN THE KAHL RESEARCH REACTOR POWER PLANT. E. Zastrow (Rheinisch-Westfälisches Elektrizitätswerk A.G., Essen, Ger.). Atomwirtschaft, 6: 66-72(Jan. 1961). (In German)

For the primary and auxiliary circuits, austenitic steels and steel plated with austenite were selected because of their corrosion resistance. Special attention was given to the degree of activation shown by materials near the core. Carbon steel and stainless steels, the Zr alloy cladding of the fuel elements, and the heat treatments and pickling used are described. (auth)

14036 PRESSURE VESSEL, CONDENSER SUPERCOOLER, AND TUBING. R. Franzl (Mannesmann Rohrleitungsbau GmbH., Duesseldorf), H. Henseler, H. Heusler, and L. Menke. Atomwirtschaft, 6: 73-9(Jan. 1961). (In German)

In the manufacture of Kahl reactor parts subjected to pressure, special problems arise because of the large wall thickness, special materials, and severe requirements on the precision of individual parts. The materials, welding procedures, and testing for each component are described. (J.S.R.)

14037 THE STEAM CONVERTER FOR THE KAHL ATOMIC POWER PLANT. H. Geismann and A. Thiel (Gutehoffnungshutte Sterkrade Aktiengesellschaft, Sterkrade, Ger.). Atomwirtschaft, 6: 80-1(Jan. 1961). (In German)

The steam converter for the first stage uses ferritic steel plated with a high alloy steel as the basic material for the jacket on the primary side. The tube bulkheads are built up by welding on both sides with a chrome-nickel steel. (auth)

14038 CONSTRUCTION AND USES OF AEG TEST REACTOR. Gerhard Riesch (Allgemsine Elektricitats-Gesellschaft, Frankfurt am Main). Atomwirtschaft, 2: 105-11(Feb. 1961). (In German)

The AEG test reactor which became critical for the first time Jan. 27, 1961, is described, and its uses are summarized. The fuel elements are 20% enriched U_3O_8–Al made by the picture-frame technique. These plates are arranged

in water-filled boxes in the core. An auxiliary moderator and reflector of graphite blocks is provided. There are 16 aluminum-clad cadmium sheets for control and safety rods. Other features of the reactor are described in detail. The reactor will be used primarily in studies of dynamic behavior and control-rod effectiveness. It can also be used for determining multiplication factors, temperature or steam void coefficients, and cross sections. (T.R.H.)

14039 THE TEMPERATURE MEASUREMENTS OF THE WWR-S REACTOR FUEL ELEMENT WALL.

W. Byszewski, J. Aleksandrowicz, and L. Łabno (Inst. of Nuclear Research, Warsaw). Nukleonika, 5: 727-36 (1960). (In Russian)

A method for temperature measurements with a chromel-alumel thermocouple in the can of a WWR-S reactor fuel element was developed. The temperature distributions along the fuel-element wall by various reactor power level were measured. The results are discussed from the point of view of the increasing nominal reactor power level. (auth)

WASTE DISPOSAL AND PROCESSING

14040 (CF-60-8-89) SOLIDIFICATION OF RADIOACTIVE LIQUID WASTE BY POT CALCINATION. C. W. Hancher, H. W. Godbee, J. T. Roberts, J. J. Perona, and J. I. Blomeke (Oak Ridge National Lab., Tenn.). Nov. 29, 1960. 16p.

Presented at the Winter Meeting of the American Nuclear Society, General Session, December 11-14, 1960.

The pot calcination process for converting high-activity waste to solids for permanent disposal consists of evaporation to dryness and calcination at 900°C in a portable stainless-steel pot, which can be used as the final storage container. Off-gases are processed by condensation, absorption, and fractionation. Calcination rates corresponding to 20 liters of concentrated waste per hour were demonstrated in 6- and 8-in.-diameter by 84-in.-high stainless-steel pots with a total noncondensable off-gas production of less than 200 liters/hr. The process is simple and versatile enough to handle the variety of wastes produced by a multipurpose power-reactor fuel-processing plant. (auth)

14041 (HW-67698) PRELIMINARY REPORT ON THE CHARACTERIZATION OF PUREX TANK FARM RADIOACTIVE CONDENSATE WASTE. J. M. Skarpelos (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 6, 1960. Contract AT(45-1)-1350. 11p.

The waste stream created by condensing vapors given off by the boiling high-level wastes in the underground Purex Tank Farm was characterized in order to study the possibility of recycling this stream to the Purex Plant. The radioisotopes present in the stream are Ce^{144}, Cs^{137}, Nb^{95}, Ru^{103}, Ru^{106}, Sr^{89}, Sr^{90}, Y^{91}, and Zr^{95}, and the nonradioactive impurities present are soluble and emulsified organic compounds, which are primarily butyl phosphates and hydrocarbon diluent. Tests are necessary to determine the possible adverse effects of the organic compounds on the mineral beds if the stream is recycled to the Purex Plant for process use. (D.L.C.)

14042 (NAA-SR-Memo-3927) DUST COLLECTION SYSTEM FOR PIQUA RESIDUE HANDLING PROTOTYPE. R. R. Stiens (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 28, 1959. 7p.

Methods of removing radioactive particulate matter from the Piqua OMR stack gas stream were evaluated. Data and other information indicated that a cloth bag collector with Dacron filter bags for operation at high temperature was best suited. (J.R.D.)

14043 (NP-9905) SEDIMENTATION OF RADIOACTIVE WASTES IN THE SEA. Michael Waldichuk (Canada. Fisheries Research Board, Nanaimo, B. C.). Jan. 1961. 39p.

Sedimentation, if it occurs at large distances from shore outside of bottom fishing areas, can be considered a favorable process in effective radioactive waste disposal. Being a concentrating process, however, it can enter into one of the routes of radioactivity from the sea to man through contamination of fish products, edible sea weed, fishing gear, and beaches. Flocculation, sorption, precipitation, and ion exchange reactions would probably occur freely in Pacific coastal waters, because of the presence of silt-laden water from the Columbia River, Fraser River, and other western streams. While turbid waters from runoff and coastal pollution can be expected to contribute to substantial sedimentation, no quantitative values can be assigned for this effect. Provided that it removes the radioactive wastes from man's environment and deposits them in areas where they can do no harm, sedimentation can be considered as a safety factor in estimates of maximum permissible release of radioactive wastes. If contamination of marine products by ingestion and sorption of the precipitated waste occurs, the effect that this would have on man's uptake of radioactivity through utilization of the products must be taken into account in evaluations. A review is given of the investigational results on radioactive waste discharge into the Irish Sea from the Windscale Works, England. A large proportion of the released radioactivity has been found in the sea bed near the outfall. Sea waters in this area are almost completely mixed vertically and contain a high concentration of suspended material. There is no reason to believe that liquid radioactive wastes discharged off the Pacific Coast of North America would behave in the same way as those released into the Irish Sea, in view of the different oceanographic conditions. A series of studies in the field and laboratory needed to elucidate some of the problems related to sedimentation of fission-product elements is suggested. 37 references. (auth)

14044 (NYO-9651) FIXATION OF ZIRCONIUM-CONTAINING FISSION PRODUCT WASTES IN NATURAL AND ARTIFICIAL GLASSES. Period Covered September 1959-September 1960. D. L. Ketcham, J. D. Sehgal, and R. Eliassen (Massachusetts Inst. of Tech., Cambridge. Sedgwick Labs. of Sanitary Science). Feb. 10, 1961. Contract AT (30-1)-621. 51p.

On the basis of studies conducted on zirconium-bearing reactor-fuel reprocessing wastes it was concluded that stable glasses can be prepared from calcined zirconium wastes mixed with CaO, SiO_2, and Al_2O_3 with up to 15% of wastes in the glasses. Stable glasses can also be prepared from igneous rocks and industrial slags mixed with calcined zirconium wastes and fired to fusion temperature. The corrosion rates obtained from glasses prepared with naturally occurring materials such as igneous rocks have the same order of magnitude as those obtained from relatively pure components. More than 15% of calcined waste cannot be incorporated in a glassy media obtained from the naturally occurring materials investigated. (C.H.)

14045 RADIOACTIVE WASTES FROM NUCLEAR REACTORS. M. Francini and G. Bertozzi (C.N.R.N., Ispra, Italy). Acqua ind., No. 7-8, 10p. (May-Aug. 1960). (In Italian) (CNI-51)

Radioactive waste problems from nuclear power reactors are briefly reviewed. Only operational power reactor wastes are discussed. The origin of such wastes was investigated. Qualitative and quantitative data on contamination coolants of both the pressurized-water and the gas-cooled reactors are given. The different waste treatment processes, as well as the methods for final disposal, are briefly outlined. (auth)

14046 METHOD OF REDUCING AQUEOUS RADIOACTIVE NUCLEAR WASTES TO SOLID FORM. J. W. Loeding and A. A. Jonke. U. S. Patent 2,977,194. Mar. 28, 1961.

A method is given for converting a waste solution of aluminum nitrate containing a minor amount of ruthenium to solid form. The solution is evaporated and calcined in a fluidized bed, which is fluidized by a mixture of carbon monoxide and nitrogen, whereby volatility of the ruthenium is inhibited.